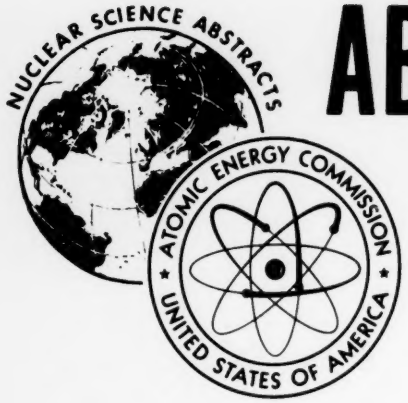
NUCLEAR SCIENCE ABSTRACTS



Volume 27 Number 4

Abstracts 7334-9264

February 28, 1973

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separation by ion exchange and complex-formation elution, 25:251(P)
TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstract 7497.

7334 MODERN ANALYTICAL CHEMISTRY. Pickering, W. F. New York; Marcel Dekker, Inc. (1971). 634p. $13.75.

An undergraduate text book is presented that focuses on analytical methodologies based on matter–energy interactions, yet also includes analytical methods based on matter–matter interactions ("chemical" analysis) that are of contemporary interest. Among the many topics covered are thermal methods; radiochemical analysis; emission spectroscopy; atomic and molecular absorption spectroscopy; kinetic methods of analysis; and gas and liquid chromatography. (D.H.M.)

Activation and Nuclear Reaction Procedures

Refer also to abstract 7649.

7335 (EIR–214) INSTRUMENTAL ACTIVATION ANALYSIS OF TRACE ELEMENTS IN ROMAN LEAD OBJECTS. Schubiger, P. A. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Jul 1972. 112p. (In German). Dep. NTIS (U. S. Sales Only).

Antique Roman lead objects were irradiated with neutron doses 10^{17}n/cm^2 for four hours. The γ spectrum was then recorded by Ge(Li) detectors and evaluated by computer. 75 objects were analyzed for Sn, Au, Cu, As, Sb, and Ag. In comparison to lead bars, lead pipes contained significantly higher amounts of tin and gold, while As, Sb, Cu, and Ag were similar. It was assumed that the Romans intentionally added tin to the lead piping with gold as a fortuitous intrusion. It was impossible to distinguish between different mines on the basis of trace metal contents in lead bars. (H.B.G.)

7336 (LA-DC–72-1414) ISOTOPIC CARBON ANALYSIS WITH LOW ENERGY PROTONS. Close, D. A.; Evans, A. E.; Malanify, J. J.; Umbarger, C. J. (Los Alamos Scientific Lab., N. Mex.). 1971. 10p. (CONF-721113–1). Dep. NTIS.

From Meeting of the American Physical Society, Seattle, WA (2 Nov 1972).

A nondestructive method using charged particle activation analysis that is capable of measuring ^{13}C concentration as well as determining $^{13}C/^{12}C$ ratio is described. The method utilizes the properties of proton capture reactions and the detection of the emitted γ rays by a γ-ray spectrometer. (D.H.M.)

7337 COMPUTER ORIENTED SYSTEM FOR NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS. de Bruin, M.; Korthoven, P. J. M. (Interuniversity Reactor Inst., Delft, Netherlands). Anal. Chem.; 44: No. 14, 2382-5(Dec 1972).

The nondestructive activation analysis system operating at the Interuniversity Reactor Institute at Delft (The Netherlands) is described. Sample and standard preparation times were reduced by application of the single comparator method. A computer-controlled sample changer was developed to keep the system operational for 24 hours a day. The computer used for data acquisition is also used for analysis of the γ spectra obtained. (M.C.G.)

7338 PEAK BOUNDARY SELECTION IN PHOTOPEAK INTEGRATION BY THE METHOD OF COVELL. Heydorn, Kaj; Lada, Witold (Danish Atomic Energy Commission Research Establishment, Risoe, Denmark). Anal. Chem.; 44: No. 14, 2313–17(Dec 1972).

The relationship between the precision of photopeak integration by the method of Covell and the number of channels used in the calculation was studied mathematically as well as experimentally in activation analysis. A Gaussian peak superimposed on a straight line is used in the mathematical development, and a functional relationship between relative peak height, peak width, and integration width was established for which maximum relative precision would be achieved. A graphical representation of this relationship permits direct application for practical purposes. For the experimental investigation series of spectra of precisely known admixtures of ^{54}Mn to ^{59}Fe were generated, using the NaI(Tl) scintillation detector as well as the Ge(Li) semiconductor detector. Excellent agreement with predicted points of maximum precision was observed, and a calculated optimum integration half-width of 0.91 × full width at half maximum for small relative peak heights was confirmed. (auth)

7339 INFRARED SPECTROPHOTOMETRY FOR CARBON IN SILICON AS CALIBRATED BY CHARGED PARTICLE ACTIVATION. Endo, Yoshiyuki (Komatsu Electronic Metals Co., Hiratsuka, Japan); Yatsurugi, Yoshifumi; Akiyama, Nobuyuki; Nozaki, Tadashi. Anal. Chem.; 44: No. 14, 2258–62(Dec 1972).

The calibration curve for infrared spectrophotometry of carbon in semiconductor silicon is presented based on data obtained for single-crystal silicon already analyzed for carbon by charged particle activation. The curve thus obtained gives carbon contents lower by a factor of about 0.75 than the previously used curve. When silicon carefully analyzed by activation is used as the reference of the spectrophotometry, carbon as low as 50 wt ppB can be detected at room temperature. For concentrations over 500 wt ppB, the relative error can be regarded as usually less than 10%. Attention should be paid, however, to the existence of carbon insensitive to the present spectrophotometry. Usefulness of the spectrophotometry is exemplified by the measurement of carbon distribution in silicon rods. (auth)

7340 CHEMICAL BEHAVIOR OF CARBON IN HIGH-PURITY SILICON IN THE DISSOLUTION AND FUSION OF THE MATRIX. Nozaki, T. (Inst. of Physical and Chemical Research, Wako, Japan); Makide, Y.; Yatsurugi, Y.; Endo, Y.; Akiyama, N. Bull. Chem. Soc. Jap.; 45: No. 9, 2776-8(Sep 1972).

The behavior of carbon in high-purity silicon in the dissolution and fusion of the matrix was studied by the ^{11}C-tracer technique. Silicon samples containing ^{11}C, either atomistically dispersed or mainly coagulated as SiC, were prepared. In alkali dissolution, no loss of ^{11}C was observed, and carbon originally dispersed in silicon behaved in a similar way to colloidal carbon under subsequent treatments. By $HF-HNO_3-KIO_4$ dissolution and succeeding $KMnO_4$ treatment, the dispersed carbon was oxidized almost quantitatively but the SiC coagulates were not completely decomposed. In alkali fusion a part of ^{11}C was lost. By fusion with $Pb_3O_4-B_2O_3$, carbon in both states was converted into CO_2. The results suggest a possible application of activation analysis to the measurement of the coagulation degree of carbon in high-purity silicon. (auth)

7341 QUESTIONS ON THE CLASSIFICATION OF NUCLEAR ANALYTICAL METHODS. Egiazarov, B. G. Yadern. Priborostr.; No. 13, 123-30(1970). (In Russian).

The classification scheme of nuclear analytical methods using as a criterion for classification the different nuclear reactions of the primary (activating) radiation is examined. The possi-

bility of the selection of other classifying criteria, based on the form of the secondary radiation, is also discussed. (tr-auth)

7342 NEUTRON ACTIVATION METHOD FOR DETERMINING SELENIUM CONTENT IN NATURAL WATERS. Abdullaev, A. A.; Nishanov, P. Kh.; Sharipov, E. B. (Inst. of Nuclear Physics, Tashkent). pp 125-7 of Neitronno-Aktivatsionnyi Analiz. /Lobanov, E. M. (ed.). Tashkent; Institut Yadernoi Fiziki, Akademiya Nauk Uzbekskoi SSR (1971). (In Russian).

The Se in natural water, which is an indication of a presence of sulfide ores, can be determined at concentrations $>1 \times 10^{-10}$ g/ml with accuracies of ±10 to 20% by a neutron activation technique based on 8 to 10 hr irradiation at a flux of 1.8×10^{13} n/cm^2 sec of 50 to 100 ml samples evaporated to dryness prior to irradiation. Following a cooling off period of 2 to 3 days the irradiated ^{75}Se and 10 mg carrier Se are dissolved in a mixed HCl + HNO_3 (6 : 1) and the ^{75}Se precipitated out with $N_2H_4 \cdot HCl$ is analyzed by γ-spectrometry by using a 40 × 40 NaI(Tl) scintillator together with an AI-100-1 (100 channel) analyzer. (Selenium-Tellurium Abstr.)

7343 INSTRUMENTAL NEUTRON ACTIVATION METHOD FOR COPPER, ZINC, AND MANGANESE DETERMINATION IN POULTRY FEATHERS. Atlavin. A. B.; Dubinskaya, N. A. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis; No. 7, 58-62(1972). (In Russian).

An instrumental neutron activation method was developed for the determination of copper, zinc, and manganese in chicken feathers, previously treated with boiling distilled water for 1.5 minutes. Element detection threshold in samples with the mass of ~50 mg equals $\sim 1.5 \times 10^{-6}$ g for zinc, $\sim 2.5 \times 10^{-8}$ g for copper, and $\sim 1.4 \times 10^{-9}$ g for manganese. (auth)

7344 INVESTIGATION ON ACTIVATION ANALYSIS WITH PHOTONS. Suzuki, N.; Honda, J.; Kato, T. (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 2, 117-21(Feb 1972). (In Japanese).

A method is described for the bremsstrahlung activation determination of Zr utilizing the ^{90}Zr(γ,n)^{89}Zr reaction. Eight standard rocks were selected as samples and irradiated with 30 MeV bremsstrahlung obtained from the 30 MeV electron beam of LINAC in Tohoku University. Remarkable photopeaks appear at 0.511 MeV and 0.913 MeV in γ spectra of the sample after separation. Decay curve for each peak indicates half-life of 79.3 hours which agrees with that of ^{89}Zr. Since the limiting value of this method is estimated as 0.4 μ g Zr, sensitivity is sufficient. (Japan)

7345 LOCALIZATION OF FLUORINE ALONG POLLUTED ABIES ALBA NEEDLES USING PROTON MICROANALYSIS. Garrec, Jean-Pierre; Bligny, Richard; Fourcy, Andre; Ligeon, Emile; Bontemps, Andre (CEN, Grenoble, France). Compt. Rend., Ser. D; 274: No. 25, 3467-71(19 Jun 1972). (In French).

A new method for the nondestructive determination of fluorine using protons established the considerable variations in the fluorine contents of polluted fir-tree needles and enabled comparisons to be made between the upper and lower sides of the needles. (France)

7346 QUANTITATIVE ANALYSIS OF Cr, Ba, Sb, Ag, Zn, Co, AND Fe IN NORMAL HUMAN ENAMEL AND DENTINE BY NEUTRON ACTIVATION AND HIGH RESOLUTION GAMMA-SPECTROMETRY. Retief, D. H. (Univ. of the Witwatersrand, Johannesburg); Cleaton-Jones, P. E.; Turkstra, J.; De Wet, W. J. J. Dent. Ass. S. Afr.; 25: 371-5(Oct 1970).

The concentrations of Cr, Ba, Sb, Ag, Zn, Co, and Fe were determined in normal human enamel and dentine employing instrumental neutron activation analysis. Their mean concentrations in enamel are 1.02, 124, 0.23, 0.10, 263, 0.13, and 118 ppM, respectively; and in dentine 1.99, 129, 0.69, 2.18, 173, 1.11, and 93 ppM. The need for further investigation is emphasized. (INIS)

7347 QUANTITATIVE ANALYSIS OF Sr, Au, Br, Mn, AND Na IN NORMAL HUMAN ENAMEL AND DENTINE BY NEUTRON ACTIVATION AND HIGH RESOLUTION GAMMA SPECTROMETRY. Retief, D. H. (Univ. of the Witwatersrand, Johannesburg); Cleaton-Jones, P. E.; Turkstra, J.; De Wet, W. J. J. Dent. Ass. S. Afr.; 26: 63-9(Mar 1971).

Nondestructive neutron activation analysis utilizing high-resolution spectrometry was used for the determination of Sr, Au, Mn, Br, and Na in normal human enamel and dentine. Au, Mn, Br, and Na were determined by epithermal neutron activation analysis because of the low concentration of Au, Mn, and Br in normal human enamel and dentine. The results for Na, Sr, and Mn agree with previous data. However, the values for Au and Br are slightly higher. (INIS)

7348 SOME NEUTRON ACTIVATION METHODS FOR THE DETERMINATION OF MINOR AND TRACE ELEMENTS IN ROCKS. Steinnes, E. Kjeller, Norway; Institutt for Atomenergi (1972). 133p.

Thesis.

The development in activation analysis of geological materials is briefly reviewed. Different techniques that have been used, with respect to counting systems, radiochemical separations, and energy spectrum of neutrons, are described. Reprints of sixteen papers published from 1966 to 1971 are also included. (D.H.M.)

7349 RADIOCHEMICAL SEPARATION OF ZIRCONIUM AND HAFNIUM FROM OTHER RADIONUCLIDES. Hahn, R. B. (Atomic Energy Research Establishment, Harwell, Eng.). Talanta; 19: No. 11, 1454-7(Nov 1972).

Radiozirconium and radiohafnium may be separated from all other radionuclides except scandium and protactinium by precipitation with mandelic acid from 5 to 10 M hydrochloric acid, using commercial zirconyl chloride as carrier. Scandium and protactinium are removed by dissolving the precipitate in sodium carbonate, then adding barium nitrate to precipitate barium carbonate which acts as a scavenger. Zirconium mandelate is finally reprecipitated and the sample weighed and counted in this form. The method was checked by analyzing commercial zirconyl chloride and standard rock samples for zirconium and hafnium by neutron-activation analysis. (auth)

7350 METHOD AND DEVICE FOR THE DETERMINATION OF FISSIONABLE MATERIAL IN SAMPLES, AS, e.g., NUCLEAR FUEL ELEMENTS. Michaelis, W. (to Gesellschaft fuer Kernforschung mbH). German Patent 1,648,901. 3 Feb 1972. (In German).

A nondestructive method for the determination of fissionable materials by means of thermal neutrons, as well as the measuring device belonging to it has been developed. The sample, a fuel element, is irradiated with a monoenergetic collimated neutron beam and the prompt gammas emitted from the sample perpendicular to the beam direction are measured with a Ge(Li) detector. The fission neutrons produced in this process are measured by means of a liquid scintillation detector surrounding the sample, and the gammas coinciding with these are suppressed in the neutron-capture gamma spectrum by means of an anticoincidence arrangement. (GF)

Chemical and Spectral Procedures

Refer also to abstracts 7396, 7491, 7650, and 7709.

7351 SEPARATION OF RARE-EARTH ELEMENTS BY IONIC MOBILITIES. Konstantinov, B. P.; Lyadov, N. S.; Oshurkova, O. V. (Ioffe Inst. of Physics and Tech., Leningrad). J. Appl. Chem. USSR (Engl. Transl.); 45: No. 5, 995-9(May 1972). Translated from Zh. Prikl. Khim.; 45: No. 5, 963-9(May 1972).

The sequence of migration of rare earths to the cathode in aqueous solutions of nitrate and acetate salts is strongly influenced by formation of complexes by rare earths with nitrate and acetate ions, respectively. Aqueous acetate solutions are suitable for analysis of relatively simple mixtures (with seven or fewer components). (auth)

7352 TRACE METALS IN ATMOSPHERIC PARTICULATE AND ATOMIC ABSORPTION SPECTROSCOPY. Hwang, J. Y. (Instrumentation Lab., Inc., Lexington, MA). Anal. Chem.; 44: No. 14, 20A-4A; 26A-7A(Dec 1972).

Trace metal particulate samples may be determined by atomic absorption spectroscopic methods. Improved results can be obtained by various sampling techniques, preconcentration, and the use of flameless methods. Major sources of trace metals in air pollution and their effects on human health are listed. Urban air samples and yearly averages for some trace metals are given. Sensitivities for determination of As, Be, Bi, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Sn, Ti, V, and Zn are given. (46 references). (M.C.G.)

7353 HIGH ACCURACY DETERMINATION OF CALCIUM IN BLOOD SERUM BY ISOTOPE DILUTION MASS SPECTROMETRY. Moore, L. J.; Machlan, L. A. (National Bureau of Standards, Washington, DC). Anal. Chem.; 44: No. 14, 2291-6 (Dec 1972).

An isotope dilution technique utilizing thermal ionization mass spectrometry was developed for the accurate determination of calcium in synthetic and serum samples at the 100 μg/g level. Calcium was separated from a serum matrix by destruction of the organic matter with $HClO_4$ and HNO_3 followed by ion-exchange separation from interferences using AG 50W-X8 100-200 mesh resin. A mass spectrometric isotopic analysis procedure was developed using a $Ca(NO_3)_2$ solution deposited on Re sample filaments in a triple filament thermal ion source. The relative error between calculated and experimentally determined con-

centrations in synthetic calcium solutions was ≦~0.1%. The 95% limit of error for a single analysis was ~0.2% for synthetic and serum samples. A comparison of the isotope dilution data with concurrently determined atomic absorption data from several clinical and independent laboratories is presented. (auth)

7354 DESIGN AND OPERATION OF TEMPERATURE-CONTROLLED MULTIPLE ELEMENT ELECTRODELESS DISCHARGE LAMPS FOR ATOMIC FLUORESCENCE SPECTROMETRY. Patel, B. M.; Browner, R. F.; Winefordner, J. D. (Univ. of Florida, Gainesville). Anal. Chem.; 44: No. 14, 2272-7(Dec 1972).

The preparation of multiple-element electrodeless discharge lamps for Hg, Cd, In, Ga, Tl, Zn, Cu, Fe, Mg, Ag, Ge, Sn, Pb, Th, U, and Zr is described. The lamps are excited using a temperature-controlled antenna system. The spectral radiant output from each individual element in a multiple-element lamp is very temperature sensitive, but largely uninfluenced by the presence of the other elements (or compounds). Plots of the variation of spectral radiant output with temperature allow the rational choice of a compromise operating temperature for several elements in each lamp. Alternatively, the optimum temperature for each element present may be selected in turn. A comparison is made between the output stability of the multiple-element lamps and the corresponding single-element lamps. Atomic fluorescence detection limits are given, using both multiple-element and single-element lamp sources. (auth)

7355 DETERMINATION OF Zr, Mo, AND Zn IN SYNTHETIC MIXTURES BY AMPEROMETRIC TITRATION WITH A TANTALUM ELECTRODE. Zhdanov, A. K.; Akent'eva, N. A.; Zakirov, B. G. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 2, 37-8(1971). (In Russian).

A method of analysis of a mixture of Zr, Mo, and Zn is proposed, based on varying degrees of stability of their complexes with Complexon III at different pH values. One aliquot of the solution was used to determine Zn at a pH of 0.4, and then total Mo–Zn at a pH of 5, titrating with a rotating electrode. A second aliquot was reserved for determining Mo by its stable complex with citrate ion. Titration of each aliquot required about 12 minutes. (K.S.W.)

7356 SPECTROPHOTOFLUOROMETRIC DETERMINATION OF TERBIUM WITH α,α'-ETHYLENEDIIMINODI(o-HYDROXYPHENYLACETIC ACID). Taketatsu, T.; Yoshida, S. (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Jap.; 45: No. 9, 2921-3(Sep 1972).

Fundamental conditions for spectrophotofluorometric determination of terbium using α,α'-ethylenediiminodi(o-hydroxyphenylacetic acid) (EDDHA) are described. The fluorescence was a linear function of concentration in the range from 0.03 to 1.5 μg/ml of terbium. By amplifying the sensitivity of the instrument, the linear relationship was obtained for solutions containing from 0.0015 to 0.015 μg/ml. (M.C.G.)

7357 PHOTOMETRIC IODIDE DETERMINATION IN THE PRESENCE OF EXCESS CHLORIDES AND BROMIDES. Novak, J.; Slama, I. (Inst. of Inorganic Chemistry, Prague). Collect. Czech. Chem. Commun.; 37: No. 9, 2907-10(Sep 1972). (In German).

A simple rapid photometric method was developed for determination of iodide in the presence of excess chlorides and bromides in eutectic potassium and lithium chloride mixtures. A palladium(II) chloride solution served as the reagent. Iodine in amounts of 2×10^{-6} to 8×10^{-6} mol could be determined in samples containing a thousand-fold excess of alkali metal chlorides and bromides. (tr-auth)

7358 NOTE ON SUCCESSIVE COMPLEXOMETRIC DETERMINATION OF THORIUM AND RARE EARTHS. Pribil, R.; Vesely, V. (Ceskoslovenska Akademie Ved, Prague). Talanta; 19: No. 11, 1448-9(Nov 1972).

A method is described for the successive complexometric determination of thorium and rare earths. The thorium is titrated at pH 2 ± 0.1, using EDTA as titrant and Xylenol Orange (XO) as indicator. Acetylacetone–acetone mixture is then added, to prevent the formation of the colored Th–EDTA–XO complex. The pH is adjusted by adding saturated hexamine solution until an intensely red-violet color appears. A further titration with EDTA is carried out to a pure yellow or slightly orange-yellow. The amounts of EDTA used correspond to the thorium and the total rare earths respectively. Limitations on the use of the method are defined. (UK)

7359 DETERMINATION OF PLUTONIUM AND URANIUM IN MIXED OXIDE FUELS BY SEQUENTIAL REDOX TITRATION. Chadwick, P. H.; McGowan, I. R. (British Nuclear Fuels Ltd., Windscale, Eng.). Talanta; 19: No. 11, 1335-48(Nov 1972).

The use of a sequential determination of uranium and plutonium in a single sample solution results in a saving in analysis time and apparatus requirements. The method starts with U(IV) and Pu(III) in a mixture of sulfuric and nitric acids. Titration with dichromate, using amperometry at a pair of polarizable electrodes, produces two well-defined end-points corresponding to the sequential oxidation of U(IV) to U(VI) and Pu(III) to Pu(IV). The quantitative oxidation of U(IV) to U(VI) is achieved via the action of Pu(IV) as intermediate, and is dependent upon establishing conditions which favor rapid reaction between U(IV) and Pu(IV). The method is precise and accurate. With Pu–U mixtures containing between 15 and 30% plutonium the precision (3σ) of the Pu : U ratio results is ±0.6% on samples containing 100 to 120 mg of plutonium plus uranium. Iron and vanadium interfere quantitatively with plutonium, copper interferes non-quantitatively with uranium, and gross amounts of molybdenum mask the uranium end-point. (auth)

7360 CONTROLLED POTENTIAL COULOMETRY: THE APPLICATION OF A SECONDARY REACTION TO THE DETERMINATION OF PLUTONIUM AND URANIUM AT A SOLID ELECTRODE. Fardon, J. B.; McGowan, I. R. (British Nuclear Fuels Ltd., Windscale, Eng.). Talanta; 19: No. 11, 1321-34 (Nov 1972).

A method is described for the simultaneous determination of plutonium and uranium in mixed oxides by controlled potential coulometry at a gold working electrode in two stages: first a coulometric oxidation, at 0.73 V vs. a silver/silver chloride electrode, of Pu(III) and U(IV) to Pu(IV) and U(VI) by a combination of a direct electrode reaction and a secondary chemical reaction proceeding concurrently, and secondly, a coulometric reduction at 0.33 V of Pu(IV) to Pu(III), leaving uranium as U(VI). The determination is carried out in a mixture of sulfuric and nitric acids, and Ti(III) is used to reduce plutonium and uranium to Pu(III) and U(IV) before electrolysis. The precision (3σ) of Pu : U ratio results obtained from mixtures containing about 30% and 2% plutonium was 0.5% and 1.5%, respectively. The effect of experimental variables on the time taken to complete the coulometric determination is discussed. (auth)

7361 PLUMBOMETRIC DETERMINATION OF Mo AND W IN THE PRESENCE OF ERYTHROSINE AS A FLUORESCENT ABSORBING INDICATOR. Maksimycheva, Z. T.; Andrushko, G. S.; Talipov, Sh. T. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 3, 26-7(1971). (In Russian).

The mechanism of erythrosine indicator in the plumbometric titration of Mo and W was investigated. Freshly prepared suspensions of lead molybdate or lead tungstate functioned as the sorbent for the erythrosine. The centrifugate was analyzed by its fluorescence intensity at λ = 552 nm. An alternate procedure as recommended involves titrating the sample–erythrosine mixture with $Pb(NO_3)_2$ to the disappearance of the yellow fluorescence. (K.S.W.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 7496, 7686, and 8962.

7362 (DP-1241(Del.)) FISSION PRODUCT CALCULATIONS AND MEASUREMENTS IN HIGHLY IRRADIATED, HIGHLY ENRICHED URANIUM. Perkins, W. C.; Christman, R. P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct 1972. Contract AT(07-2)-1. 17p. Dep. NTIS.

The CINDER computer program is a valuable tool for calculating fission product activities in nuclear reactor fuel and targets. CINDER predicts the activities of ^{103}Ru, ^{106}Ru, ^{134}Cs, ^{137}Cs, and ^{144}Ce within an average standard deviation of 19%. However, only 10% of the ^{95}Nb and 68% of the ^{95}Zr predicted by CINDER were found in solutions of irradiated enriched uranium. Large amounts of ^{95}Nb and some ^{95}Zr were found in the colloidal, siliceous solids that form during dissolution of this fuel. The ^{95}Nb/^{95}Zr ratios measured in solution indicate that almost all of the ^{95}Nb had been removed from solution by these solids at the time the fuel was dissolved. (auth)

7363 (KFKI-72-51) GAMMA SPECTROMETRIC DATA PROCESSING FOR ENVIRONMENTAL SAMPLE ANALYSIS. Kovacs, M.; Beleznay, E.; Andrasi, A.; Erdelyvari, I. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1972. 15p. Dep. NTIS (U. S. Sales Only).

A computerized gamma-spectrometric method is described that is suitable for fast measurement, decomposition and evaluation of the activity of samples containing no more than 8 components without the need for analytical processing. The efficiency of the DAS2 program, which performs the decomposition by the method of weighted least squares, is demonstrated on a few examples. Compilation of the required standard spectrum library and the

measurement of detection limits are also discussed. The applicability of the method is illustrated by a comparison of results obtained in parallel gamma spectrometric and chemical analyses of some ashed food samples. The final section sets out the advantages and drawbacks of the method and points out its possible practical scope. (auth)

7364 (LA–5008) HISTORY OF THE PLUTONIUM BIOASSAY PROGRAM AT THE LOS ALAMOS SCIENTIFIC LABORATORY, 1944–1972. Campbell, E. E.; Milligan, M. F.; Moss, W. D.; Schulte, H. F. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 7p. Dep. NTIS.

A chronological description is given of the methods used in the plutonium bioassay program at Los Alamos. Methods of urine-sample collection, radiochemical separation, and counting are described briefly. (auth)

7365 (TID–26206) 1972 RESULTS OF THE CONTINUED INTERCOMPARISONS OF METHODS FOR ANALYSES OF CESIUM, COBALT, SILVER, AND OTHER RADIONUCLIDES SPONSORED BY IAEA. PART II. ANALYSIS OF DRIED SEAWEED SAMPLES COLLECTED BY BRITISH FISHERIES RADIOBIOLOGICAL LABORATORY. Folsom, T. R.; Hodge, V. F.; Wong, K. M. (Scripps Institution of Oceanography, La Jolla, Calif. Soledad Lab.). 31 May 1972. Contract AT(04-3)-34. 3p. Dep. NTIS.

Measurements for ^{134}Cs, ^{137}Cs, ^{60}Co, and ^{110m}Ag in subsamples of IAEA dried seaweed samples are reported. The two cesium nuclides and ^{60}Co were analyzed nondestructively by use of a two-dimensional γ spectrometer and also by one-dimensional analyses. Silver-110m was analyzed by two dimensional methods after extraction from 26.8 grams of dried seaweed by electrodeposition from a potassium cyanide mixture utilizing silver carrier. (D.H.M.)

7366 (TID–26208) PLUTONIUM CONCENTRATIONS OF IAEA SEAWEED SAMPLES. Folsom, T. R.; Hodge, V. F.; Wong, K. M. (Scripps Institution of Oceanography, La Jolla, Calif. Soledad Lab.). 23 Jun 1972. 3p. Dep. NTIS.

Addendum to TID–26206.

Data are presented for the plutonium concentration (^{238}Pu, $^{239,240}Pu$) in 3 IAEA seaweed samples. (D.H.M.)

7367 ION BEAM SYSTEMS FOR SURFACE ANALYSIS. Hurley, R. E. (Edwards High Vacuum Ltd., Crawley, Eng.). J. Phys., E (London): 5: No. 11, 1025-36(Nov 1972).

Ion beam systems and their component parts used for analysis of solid surfaces are reviewed. The energy range under consideration for the primary beam system is of the order of a few keV to several hundred keV with ion currents up to 1 mA. Ion production, acceleration and focusing, analysis, beam handling, and detection facilities are discussed together with some examples of complete systems. (auth)

7368 LOSS OF GOLD DURING SAMPLE DISSOLUTION. Moore, H. A.; Wessman, R. A. (Trapelo/West, Richmond, CA). Anal. Chem.; 44: No. 14, 2398-2400(Dec 1972).

Significant amounts of gold are volatilized during dissolution of IPC paper with fuming HNO_3 and $HClO_4$. Tracer studies using ^{195}Au confirmed this. If it is desired to measure radioactive gold in the sample, conventional radiochemical methods should be used with standardized gold carrier added to the sample before dissolution. (M.C.G.)

7369 ISOTOPE EXCITED X-RAY FLUORESCENCE. Kneip, T. J.; Laurer, G. R. (New York Univ., NY). Anal. Chem.; 44: No. 14, 57A-8A; 60A; 63A-4A; 66A; 68A(Dec 1972).

Major parameters in the development of isotope source x-ray fluorescence systems are considered, including chemical and physical properties of the sample, isotopic source characteristics, detector resolution and efficiency, and source-sample-detector geometry. Possibilities for application of sub-ppM simultaneous multielement analysis of blood appear promising. The central source system, annular source, and concentric source-sample system are described. (M.C.G.)

7370 APPARATUS FOR THE PREPARATION OF LIQUID FORM SAMPLES FOR RADIOACTIVE ISOTOPE TRACER STUDIES. Kaartinen, N. H. (to Packard Instrument Co., Inc.). U. S. Patent 3,682,598. 8 Aug 1972. Filed 29 Apr 1969.

Refinements are provided in a system for preparing liquid samples for radioactive nuclide assays. In the basic system, a primary sample containing at least one radioactive nuclide oxidizable to a recoverable gas-form oxide is oxidized, and the resulting combustion products are treated for the recovery of the radioactive nuclide oxide as a final liquid sample. Advantageously, near the beginning of the oxidation, a gas-form oxide of a non-radioactive isotope of the radioactive nuclide is introduced. This introduction simultaneously increases recovery of the radioactive nuclide and decreases "memory" of the system. Where the introduced oxide is water, corresponding to tritium in the primary sample, the resulting apparatus is additionally useful for monitoring both memory and background count, for making quenched standard samples uncontaminated by atmospheric oxygen, and for matching water quenching in samples obtained from primary samples of different size. (Official Gazette)

7371 DETERMINATION OF CONCENTRATION OF RADON DAUGHTERS BY LIQUID SCINTILLATION TECHNIQUE. Kurosawa, Ryuhei (Waseda Univ., Tokyo). Waseda Daigaku Rikogaku Kenkyusho Hokoku; No. 52, 1-11(Jun 1971). (In Japanese).

A method for determining the radon daughter concentration in the atmosphere using liquid scintillation counting technique is presented. After sampling, the filter was dissolved in 6 ml of methyl alcohol then mixed with 13 ml of toluene solution of p-terphenyl scintillator. An individual pulse height distribution pattern of the radon daughters can be determined by the variation of the pulse height distribution of ^{218}Po with elapsed time. Therefore, an individual concentration of the radon daughters can be calculated by the following equations, (sampling time: 3 min) $i_a = 1/v_s\ (0.36913A_{a3} - 0.20450A_{b3} - 0.16714A_{c3}) \times 10^{-6}$; $i_b = 1/v_s\ (-0.04206A_{a3} + 0.26632A_{b3} - 0.10974A_{c3}) \times 10^{-6}$; $i_c = 1/v_s\ (0.005392A_{a3} - 0.07945A_{b3} + 0.25823A_{c3}) \times 10^{-6}$; where A_{a3}, A_{b3}, A_{c3},: counts for 50 to 65 channel range, 20 to 40 channel range and 80 to 100 channel range (counting period: from 4 to 7 min after the end of sampling). (The pulse height of channel number 60 corresponds to the alpha particle energy of 6.0 MeV.) i_a, i_b, i_c,: concentration of ^{218}Po, ^{214}Pb, and ^{214}Bi in $\mu Ci/cm^3$. v_s: flow rate of sampling in cm^3/min. The practical limit of the determination of radon daughters concentration by this method is $3 \times 10^{-9}\ \mu Ci/cm^3$. (auth)

7372 CONTINUOUS DETECTION OF RADIOACTIVE EFFLUENTS IN LIQUID CHROMATOGRAPHY BY HETEROGENEOUS OR HOMOGENEOUS SCINTILLATION COUNTING. Schutte, L. (Unilever Research Duiven, Zevenaar, Netherlands). J. Chromatogr.; 72: No. 2, 303-9(18 Oct 1972).

Beta radioactivity in liquid chromatography effluents can be monitored by either heterogeneous or homogeneous scintillation counting. The two systems were compared and appropriate flow cells were developed. With heterogeneous counting, the solution is led through a U-shaped flow cell filled with glass scintillator beads. This system is best for preparative chromatography when activities are high and losses are unacceptable. The activity per peak should exceed 10 nCi for ^{14}C and 1 μCi for ^{3}H. With homogeneous counting, part of the effluent is mixed with a scintillator solution and passed through an empty helical flow cell. This system is best for detection of ^{3}H, low activities, and in dual-label experiments, or when complete recovery is not vital. The activity per peak should exceed 2 nCi for ^{14}C and 5 nCi for ^{3}H. (auth)

7373 SUBSTOICHIOMETRY IN RADIOACTIVE ANALYSIS. Suzuki, N. (Tohoku Univ., Sendai); Kudo, K. Jap. Anal.; 21: No. 4, 532-42(Apr 1972). (In Japanese).

Although radioisotope dilution analysis is an excellent method, characteristic of radioisotopes is not fully utilized at a stage of quantitative determination as far as "normal" chemical method such as colorimetry or precipitation are used. Considering the advantages of sensitivity and accuracy in radioactive analysis, it had been desired to develop a new method for simply determining the change of specific activity which is principle of the isotope dilution method. Therefore, substoichiometry proposed by one of the authors in 1958 has been discussed and experimented everywhere. Principle of the substoichiometry is explained for the isotope dilution method, activation analysis, determination by exchange and substoichiometric separation, respectively. An example of reproducibility in the substoichiometry is shown in a table. It shows that standard deviation for mean value is 0.5%, and well agrees within the errors of measuring radioactivity. Other application is also described, and recently, progress to the multi-element substoichiometric separation, automatic analysis, and the replacement substoichiometry has appeared. (Japan)

7374 COUNTING OF SMALL ^{147}Pm-ACTIVITIES IN FAECAL ASHES. Etzersdorfer, E.; Schoenfeld, T. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Health Phys.; 24: No. 1, 104-6(Jan 1973).

It has been found that the measurement of β radiation from faecal ashes by gas flow proportional counter is the most convenient method of measurement of inhaled or ingested ^{147}Pm. The sensitivity of the method is limited by the presence of natural ^{40}K in the ashes. Data are given indicating the extent of this limitation and the selection of optimum sample weights is discussed. With the method described ^{147}Pm is detected in faeces

at a level of InCi $^{147}Pm/g$ ash which is about 3% of the level that is produced by inhalation of (MPC) air. (UK)

7375 TRITIUM IN FOODS. I. APPARATUS FOR THE COMBUSTION OF FOODS AND INSTALLATION FOR WATER PURIFICATION TO PRODUCE WATER SAMPLES FOR THE ERMINATION OF TRITIUM BY LIQUID SCINTILLATION SPECTROMETRY. Mlinko, S.; Fischer, E.; Diehl, J. F. (Institut fuer Strahlentechnologie, Karlsruhe, Ger.). Z. Anal. Chem.; 261: No. 3, 203-8(1972). (In German).

To investigate the natural tritium content of foods a combustion apparatus was developed, in which nearly 100 ml of water are obtained in one operation from foods of any composition. To measure the tritium activity of this combustion water in the liquid scintillation spectrometer, the interfering combustion products are removed by distillation. The construction and operation of the combustion apparatus and of the water purification system are described. (auth)

7376 INVESTIGATION OF THE STOICHIOMETRY AND IMPURITY CONTENT OF THIN SILICON OXIDE FILMS USING RUTHERFORD SCATTERING OF MeV alpha PARTICLES. Morgan, D. V.; Gittins, R. P. (Univ. of Leeds, Eng.). Phys. Status Solidi (a); 13: No. 2, 517-2630(1(16 Oct 1972).

It is described how the Rutherford scattering of MeV α particles may be used to study the stoichiometry and impurity content of thin silicon oxide films. The relative concentrations of silicon to oxygen can be measured to $\approx 5\%$, and in the most favorable cases, impurity concentations as low as $\approx 10^{18}$ ions cm^{-3} can be measured. (auth)

7377 ISOTOPE IDENTIFICATION AND RADIOASSAY BY TIME INTERVAL ANALYSIS. McBeth, G. W.; Winyard, R. A. (Brighton Polytechnic, Eng.). Int. J. Appl. Radiat. Isotop.; 23: No. 11, 427-33(Nov 1972).

A new approach to isotope identification and radioassay by means of time interval analysis is described. The technique can be employed in sample counting where the isotope of interest has a state (ground or excited) of half-life 10 ns $\leq t_{\frac{1}{2}} \leq$ 1 ms populated during the decay sequence. Since this method is biased in favor of time correlated events the background is reduced by orders of magnitude and the lower limit of detection is of the order of 100 pCi. Isotope identification is rapid and unambiguous. The method is also ideally suited to routine analysis and automation as in conventional liquid scintillation counting systems. Discussion of the operation of the system with examples is given. (auth)

Separation Procedures

Refer also to abstracts 7397 and 7566.

7378 HYDRODYNAMICS AND MASS TRANSFER IN RECTIFICATION OF CADMIUM, TELLURIUM, AND SELENIUM IN PACKED COLUMNS. Taraskin, V. V.; Titov, A. A.; Nisel'son, L. A.; Ustyugov, G. P. J. Appl. Chem. USSR (Engl. Transl.); 45: No. 5, 1049-53(May 1972).

Translated from Zh. Prikl. Khim.; 45: No. 5, 1022-7(May 1972).

The dependences of the hydraulic resistance and HTU (height of a transfer unit) on the vapor velocity in high-temperature rectification of elements in columns with fine packing do not differ in principle from the analogous dependences at moderate temperatures. General analytical expressions are given for description of hydraulic resistance and mass transfer in high-temperature rectification of a number of elements of the type of Se, Te, and Cd in columns with fine packing. The hydrodynamic and mass-transfer characteristics determined in this investigation can be used for design of industrial equipment for production of highly pure Se, Te, and Cd by rectification. (auth)

7379 RARE EARTH ION REMOVAL FROM WASTE WATER. Recht, H. L.; Ghassemi, M. (to North American Rockwell Corp.). U. S. Patent 3,692,671. 19 Sep 1972. Filed 1 Oct 1970.

A method is provided for chemically removing trivalent rare earth ions from waste water by treating the trivalent rare earth ion-containing water with a carbonate salt, such as an alkali metal carbonate, to form an insoluble rare earth carbonate precipitate and then separating the precipitate from the water. The rare earth ions may be regenerated in the form of a soluble rare earth salt, for example, by treating the separated rare earth carbonate precipitate with acid, such as hydrochloric or sulfuric acid. (Official Gazette)

7380 DISTRIBUTION COEFFICIENTS AND ANION EXCHANGE BEHAVIOR OF ELEMENTS IN OXALIC ACID–HYDROCHLORIC ACID MIXTURES. Strelow, F. W. E.; Weinert, C. H. S. W.; Eloff, Cynthia (National Chemical Research Lab., Pretoria). Anal. Chem.; 44: No. 14, 2352-6(Dec 1972).

Anion exchange distribution coefficients with AG 1-X8, a strongly basic quarternary ammonium anion exchanger with a polystyrene matrix, are presented for 36 elements in oxalic acid–hydrochloric acid mixtures. The coefficients are presented in two tables ordered according to their numerical value in 1M HCl plus 0.05M (or 0.25M) oxalic acid. When this value is lower than 1, the values in 0.1 or 0.01M HCl are taken. A number of the possibilities of this system for separations are pointed out, and some aspects of the elution behavior of various elements are discussed. The versatility of the system is demonstrated by sequential elution of the mixtures Mn(II) – Ni(II) – V(V) – Nb(V) – U(VI); Mg – Al – Ga – In; Co(II) – Cu(II) – Ti(IV) – Mo(V), and Cu(II) – Al. (auth)

7381 GAS CHROMATOGRAPHY OF VOLATILE MIXED-LIGAND COMPLEXES OF THE LANTHANIDES. Sieck, R. F.; Banks, C. V. (Iowa State Univ., Ames). Anal. Chem.; 44: No. 14, 2307-12(Dec 1972).

The detection of mixed-ligand complexes of lanthanides and yttrium by gas chromatography at column temperatures of about 200°C is reported. Fluorinated β-diketones such as 1,1,1,2,2,3,3,7,7,8,8,8-dodecafluoro-4,6-octanedione and 1,1,1,2,2,6,6,7,7,7-decafluoro-3,5-heptanedione in combination with organic neutral donors such as tri-n-butylphosphate, tri-n-butylphosphine oxide, and di-n-butylsulfoxide can be used to quantitatively extract the lanthanides as mixed-ligand complexes that are volatile and thermally stable. Several combinations of ligand and neutral donor are discussed, which give excellent chromatograms for mixed-ligand complexes of each of the lanthanides and yttrium. Separations for selected mixtures of the lanthanides are shown. (auth)

7382 PAPER ELECTROPHORESIS OF METAL IONS IN EDTA: LIGAND BUFFER SOLUTIONS. II. SOME BIVALENT METAL IONS AND RARE EARTH METAL IONS. Jokl, V.; Valaskova, I. (Comenius Univ., Bratislava). J. Chromatogr.; 72: No. 2, 373-83(18 Oct 1972). (In German).

The electrophoretic mobility curves of alkaline earth ions in $Mg^{2+} - MgL^{2-}$ ligand buffer solutions containing EDTA, and those of bivalent heavy metal ions and of the complete rare earth ions group in $Zn^{2+} - ZnL^{2-}$ ligand buffer solutions at pH 4 and pH 2 were investigated. These migration media were found to be useful for the reproducible electrophoresis of metal ions. Deviations from theory and the leveling effect of ligand buffers on chelate stabilities are examined. Stability constants were estimated from the electrophoretic data both numerically and through graphical logarithmic analysis. The applicability for practical separation procedures is briefly discussed. (auth)

7383 SYNTHETIC INORGANIC ION EXCHANGERS. II. SALTS OF HETEROPOLYACIDS, INSOLUBLE FERROCYANIDES, SYNTHETIC ALUMINOSILICATES, AND MISCELLANEOUS EXCHANGERS. Pekarek, V.; Vesely, V. (Inst. of Nuclear Physics, Rez, Czech.). Talanta; 19: No. 11, 1245-83(Nov 1972).

A review is presented of developments during the period 1965 to 70 in the use of heteropoly acid salts, ferrocyanides, and synthetic zeolites as ion-exchangers. The subject is covered in sections: salts of heteropoly acids (molybdophosphates, tungstophosphates, other heteropoly acids, including isopoly acids considered as heteropoly acids of hydrogen); insoluble ferrocyanides; synthetic aluminosilicates (classified into groups related to their naturally-occurring analogues: faujasite-, mordenite-, heulandite-, chabazite-, analcite-, and phillipsite-like zeolites and other zeolites); miscellaneous exchangers (synthetic apatites, insoluble sulphides, alkaline earth sulphates). An extensive bibliography is included. (UK)

7384 SYNERGISTIC EFFECT IN THE EXTRACTION OF URANYL COMPLEX. Akiba, K. (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 2, 143-8(Feb 1972). (In Japanese).

Extraction constants and adduct formation constants of uranyl thenoyltrifluoroacetonate (TTA) chelate in the presence of trioctylphosphine oxide (TOPO) were obtained to investigate the synergistic effect. The effect of the uranyl concentration on the distribution ratio of the uranyl complex was determined by measuring the gamma activity. With the coexistence of TOPO, the distribution ratio was constant for a uranyl concentration less than 10^{-5}M. It was found that the contribution of TTA was the same as that of tributyl phosphate (TBP) and triphenylphosphine oxide (TPPO). The effect of TOPO on the formation of the 1:1 adduct complex was observed in the case of employing a solvent such as chloroform or methylene chloride, by taking the distribution ratio as a function of the TOPO concentration. The distribution ratio for cyclohexane was similar to that for chloroform. The ratio for benzene was a little different from that for chloroform, but resulted in the formation of a 1:1 adduct complex. The extraction constants and adduct formation constants of uranyl thenoyltri-

fluoroacetonate with trioctylphosphine oxide at 25°C were obtained for various solvents. (Japan)

7385 ZIRCONIUM COMPLEXES EXTRACTABLE BY TBP FROM SOLUTIONS CONTAINING A DEFICIT OF NITRIC ACID. Klyuchnikov, V. M.; Zaitsev, L. M.; Korovin, S. S.; Apraksin, I. A. Zh. Neorg. Khim.; 17: No. 11, 3030-4(Nov 1972). (In Russian).

In the absence of neutral Zr nitrate, the hydroxynitrates are extracted with the formation of complexes in which the ratio Zr:TBP = unity. During extraction from aqueous solutions which contain Zr α-oxychloride and $LiNO_3$, a series of complexes of Zr hydroxynitrates extract into the organic phase: $[ZrOH(NO_3)_3 \cdot TBP]_2$, $[Zr(OH)_2(NO_3)_2 \cdot TBP]_n$, where n = 2 to 4. Extraction occurs as a result of the presence in the aqueous solution of hydroxycompounds of Zr which have coordinated nitrate groups and is included in the TBP complex. Cryoscopic measurements indicated the degree of polymerization of the Zr in the TBP phase. Coordination of TBP to the central atom was established by ir spectroscopy of the extracts. (tr-auth)

7386 EXTRACTION OF ZIRCONIUM THIOCYANATE FROM HYDROCHLORIC ACID SOLUTIONS BY ACETOPHENONE. Vinarov, I. V.; Orlova, A. I.; Grigor'eva, L. P.; Il'chenko, L. I. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Neorg. Khim.; 17: No. 11, 3035-8(Nov 1972). (In Russian).

Thiocyanate complexes of Zr were extracted by acetophenone (AP) according to a solvate mechanism. The compositions of the solvates were determined by the parameters of the process. An extreme character of the functions $\log D_{Zr} = f \log [H^+]_{aq}$ and $D_{Zr} = f \log [SCN^-]_{aq}$ was demonstrated. In the region $[H^+]$ = 1 to 2 g · equiv./liter, the complexes predominantly extracted were $Zr(OH)_2(SCN)_2 \cdot 2AP$ or $Zr(OH)_3SCN \cdot 2AP$, or a mixture of the two. The character of the extraction of Zr and Hf thiocyanates is unique; the distribution coefficients of the latter are greater. (tr-auth)

7387 EQUILIBRIUM IN THE SORPTION OF LANTHANUM AND ERBIUM ON KB-4-2P ION-EXCHANGE RESIN IN THE SODIUM-FORM. Legenchenko, I. A.; Strizhenyuk, S. L. Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 4, 600-1(Apr 1972).

Translated from Zh. Fiz. Khim.; 46: No. 4, 1027-8(Apr 1972).

Equilibrium in the sorption of lanthanum and erbium cations on the carboxylic acid resin KB-4-2P in the sodium form was investigated. High affinity of the lanthanide cations for the resin was confirmed. An equation is proposed for the sorption equilibrium taking into account the hydrolysis of the resin. (auth)

7388 EXTRACTION OF SCANDIUM THIOCYANATE BY CHLOROFORM SOLUTIONS OF 1,10-PHENANTHROLINE AND COLLIDINE. Kirika, A. L.; Granovskii, Yu. V.; Komissarova, L. N.; Fadeeva, V. I.; Alimarin, I. P. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 2, 265-9(Feb 1972). (In Russian).

A search for the optimum conditions for the extraction of scandium thiocyanate by amine solutions in $CHCl_3$ was aided by a mathematical programming of the projected experiment. Regression equations of the second order were obtained which characterized extraction of scandium thiocyanate by $CHCl_3$ solutions of 1,10-phenanthroline and collidine, and the optimum conditions were found. (K.S.W.)

7389 EXTRACTION OF SCANDIUM COMPLEXES OF 1,10-PHENANTHROLINE–THIOCYANATE AND COLLIDINE–THIOCYANATE. Kirika, A. L.; Fadeeva, V. I.; Granovskii, Yu. V.; Komissarova, L. N.; Alimarin, I. P. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 2, 270-3(Feb 1972). (In Russian).

The mechanism of extraction of scandium thiocycanate by 1,10-phenanthroline and collidine in $CHCl_3$ in the presence of the electrolytes NaCl and $NaNO_3$ was studied by a method of mathematical programming. The nitrate ion entered into the 1,10-phenanthroline–thiocyanate complex; neither NO_3^- nor Cl^- had any affect on the collidine–thiocyanate complex. (K.S.W.)

7390 EXTRACTION OF MOLYBDENUM(VI) FROM NITRIC ACID SOLUTIONS BY TRI-n-DECYLAMINE. Shesterikov, V. N.; Shmidt, V. S.; Novikova, S. S. Zh. Neorg. Khim.; 17: No. 11, 3044-7(Nov 1972). (In Russian).

The extraction of quantities of Mo(VI) up to 45 g/l by solutions of tri-n-decylamine in benzene was demonstrated. The time required for establishment of equilibrium, and the effects of varying the concentrations of acid, NO_3^- ion, the amine, and Mo on the distribution coefficient of Mo were examined. (K.S.W.)

7391 REFINEMENT OF THE SEPARATION PROCESS FOR COPPER–MOLYBDENUM CONCENTRATES. Plaksa, N. E.; Revazashvili, B. I.; Akhmetova, D. D. Tsvetn. Metal.; No. 6, 78-9(Jun 1972). (In Russian).

Ferrocyanide is recommended as a depressor in the flotation process of separating Cu–Mo concentrates, as a cost of one kopeck/ton of concentrate. The ferrocyanide addition is to be used in conjunction with three kg Na_2S/ton. (K.S.W.)

7392 SYNTHESIS AND ION-EXCHANGE PROPERTIES OF CERIC ANTIMONATE. SEPARATION OF Hg^{2+} FROM Zn^{2+}, Cd^{2+}, Pb^{2+}, AND Tl^+; Cu^{2+} FROM Mn^{2+}; Fe^{3+} FROM Al^{3+}; AND Zr^{4+} FROM Th^{4+}. Gill, J. S.; Tandon, S. N. (Univ. of Roorkee, India). Talanta; 19: No. 11, 1355-62(Nov 1972).

Ceric antimonate has been prepared under varying conditions of precipitation. Its properties and ion-exchange behaviour have been studied. Separations of Hg^{2+} from Zn^{2+}, Cd^{2+}, Pb^{2+}, and Tl^+; Cu^{2+} from Mn^{2+}; Fe^{3+} from Al^{3+}; and Zr^{4+} from Th^{4+} have been achieved with this material. (auth)

7393 AMORPHONS AND CRYSTALLINE CER(IV)-PHOSPHATE AS AN ION EXCHANGER. 4. MACROSORPTION, TRACERSORPTION, AND NUCLIDE SEPARATION ON CRYSTALLINE CER(IV)-PHOSPHATE-SULPHATES. Koenig, K.-H.; Eckstein, G. (Johann-Wolfgang-Goethe-Univ., Frankfurt am Main). J. Inorg. Nucl. Chem.; 34: No. 12, 3771-9(Dec 1972). (In German).

Crystalline Ce(IV) phosphate sulphates of the formula $Ce_2O(HOP_4)_{3-x}(SO_4)_x \cdot 4H_2O$ with $0 \leq x \leq 1$ are cation-exchangers with ion-sieve properties in mineral acids. The ion-exchange properties against macro- and tracer-amounts for many cations including the trivalent ions of rare earths were investigated. The practical application for separation of radioelements is demonstrated. (auth)

Inorganic, Organic, and Physical Chemistry

Chemical and Physicochemical Properties

Refer also to abstracts 7340, 7819, and 8958.

7394 CHEMISTRY OF QUINQUEVALENT TECHNETIUM. Spitsyn, V. I.; Glinkina, M. I.; Kuzina, A. F. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 200: No. 6, 1372-5 (21 Oct 1971). (In Russian).

The two compounds of Tc(V): K_2TcOCl_5 and $K_2TcO(OH)Cl_4$ were synthesized, and their absorption spectra in uv, visible, and infrared regions were established. (K.S.W.)

7395 EXTRACTABLE AND NONEXTRACTABLE ZIRCONIUM (HAFNIUM) NITRATE. Yagodin, G. A.; Teterin, E. G.; Kazak, V. G. (Moscow Physico-Technological Inst.). Zh. Neorg. Khim.; 17: No. 11, 3026-9(Nov 1972). (In Russian).

Physico-chemical characteristics of extractable and nonextractable Zr (Hf) nitrate were investigated. The former was crystalline but the nonextractable was amorphous (as judged by x ray diffraction), and more heat-stable. The intense absorption band was absent from infrared spectra of the salts which usually characterizes the group Zr = 0. (tr-auth)

7396 REDUCTION OF CERIUM(IV) WITH PHOSPHINE IN THE PRESENCE OF IODIDE IONS IN SULPHURIC ACID SOLUTIONS. Sokol'skii, D. V.; Dorfman, Ya. A.; Rogoza, Z. I. (Inst. of Organic Catalysis and Electrochemistry, Alma-Ata, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 4, 578-9(Apr 1972).

Translated from Zh. Fiz. Khim.; 46: No. 4, 998-9(Apr 1972).

The kinetics and mechanism of the reduction of cerium(IV) with phosphine in the presence of potassium iodide in sulfuric acid solutions were investigated on a flow-type apparatus with a gradient-free reactor. The stability constants of cerium(IV) sulfates were calculated from the kinetic equation. (auth)

7397 TRACES OF YTTRIUM AND LANTHANIDES RADIONUCLIDES IN AQUEOUS SOLUTIONS. I. ADSORPTION OF TRACE AMOUNTS OF YTTRIUM. Polansky, P. (Zapotocky Military Academy, Brno); Bar, J. Collect. Czech. Chem. Commun.; 37: No. 9, 3024-8(Sep 1972).

Adsorption of yttrium ^{91}Y from aqueous solutions on filter paper, glass, and teflon was studied in the concentration range $\sim 10^{-11}$ to 10^{-12} M of ^{91}Y at pH 1.5 to 11.5 and at 25°C. The relative adsorption coefficients showed a maximum at pH 4 to 5 in the case of paper and glass and at pH 5 to 6 in the case of teflon. The maximum of ^{91}Y adsorption on paper was substantially decreased in the presence of 0.01 M NaCl. The observed maxima were not directly connected with the formation of the true colloid hydroxide $^{91}Y(OH)_3$ in the solution, the existence of which in the studied solutions is possible only at pH > 9 to 11. At pH <9 to 11 ^{91}Y can probably be present in the solution only in the form of ions or pseudo-

colloids. Molecular forms of yttrium contribute but little to the total activity of ^{91}Y in the whole pH range studied. (auth)

7398 SOFTNESS PARAMETERS OF IONS. PREDICTION OF THE OCCURRENCE OF MISCIBILITY GAPS IN MOLTEN SALT MIXTURES. Marcus, Y. (Purdue Univ., Lafayette, Ind.). Israel J. Chem.; 10: No. 3, 659-83(1972).

Softness parameters, σ_M for cations and σ_X for anions, were calculated as dimensionless quantities for approximately 90 cations and 18 anions. They are given by $\sigma_M = [\sigma_A(M^{m+}) - \sigma_A(H^+)]/\sigma_A(H^+)$ and $\sigma_X = [\sigma_B(X^{a-}) - \sigma_B(OH^-)]/\sigma_A(H^+)$ where $\sigma_A = [\Sigma I_i(M) + \Delta H_h^0(M^{m+})]/m$ and $\sigma_B = [-E_a(X) + \Delta H_h^0(X^{a-})]/a$ are Ahrland's parameters. The new normalized and comparative (to the test ions H^+ and OH^-) softness parameters are positive for soft ions and negative for hard ones. These parameters, obtained independently, are used with a four-coefficient equation to calculate coordinate bond energies for metal halides with acceptable accuracy. Considerations of the average coordination in reciprocal molten salt mixture lead to an expression for the metathesis energy change as proportional to the product of the differences in softness parameters of the two cations and the two anions. An empirical one-coefficient equation involving the softness parameters is proposed to deal with next-nearest-neighbor interactions in binary common-ion molten salt mixtures. These relationships are then used with Blander and Topol's equation to predict the occurrence of miscibility gaps in uni-univalent reciprocal salt mixtures. The gaps found in other systems are also discussed in terms of the softness of the constituent ions. (auth)

7399 ANNUAL REVIEW OF PHYSICAL CHEMISTRY. VOLUME 23. Eyring, H. (ed.). Palo Alto, CA; Annual Reviews Inc. (1972). 562p. $10.00.

The 18 chapters cover: history of physical chemistry in Japan; electronic spectra; electronic structure, transitions, and high-pressure chemistry and physics of solids; solutions of nonelectrolytes; inelastic light scattering and Raman effect; polyelectrolytes; infrared spectroscopy; protein structure and function; nuclear magnetic resonance; force fields in polyatomic molecules, high-pressure kinetics in solution; electron spin resonance; gas kinetics; kinetics of heterogeneous systems; perturbed angular correlation of gamma rays; quantum chemistry; theories of liquids; and chemistry of the moon. Author and subject indexes are included. A separate abstract was prepared for the chapter dealing with perturbed angular correlation of gamma rays. (D.L.C.)

For an abstract of an individual chapter see: 8957.

Isotope Effects

Refer also to abstract 7455.

7400 (NBS-SPEC. PUBL-349) HEAVY-ATOM KINETIC ISOTOPE EFFECTS: AN INDEXED BIBLIOGRAPHY. Stern, M. J.; Wolfsberg, M. (National Bureau of Standards, Washington, D. C.). Jun 1972. 37p. GPO $0.45.

A bibliography of heavy-atom kinetic isotope effects was compiled covering the complete literature from the earliest entry found (1911) through 1965. Review articles and theoretical papers are listed through 1968. The bibliography is divided into a list of the references, an author index and a subject index. The subject index has been annotated to describe, in brief, the type of reaction being observed. The following areas have been excluded: geochemistry (except for specific laboratory reactions), living systems, mass spectrometry and electron impact, electrochemistry, diffusion-controlled processes, hot-atom chemistry, photochemistry involving selective excitation of isotopes, and processes involving no chemical change. (auth)

7401 KINETIC ISOTOPE EFFECT IN THE RECOMBINATION REACTION OF HYDROGEN ATOMS ON A SILVER SURFACE. Kislyuk, M. U.; Tret'yakov, I. I.; Krylov, O. V. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 204: No. 5, 1154-7(11 Jun 1972). (In Russian).

A kinetic isotope effect in the H_2-D_2 system with a recombination on a solid surface was conducted in a silvered glass reactor at a pressure of about 10^{-10} torr. H/D atoms were obtained by means of thermal dissociation of the molecular species on a W filament suspended in the reactor. A cooling bath provided temperatures from +20 to −100°C. The reaction rate constant conformed to the log k vs 1/T relationship of Arrhenius, and the observed isotope effect was $k_H/k_D \approx 10$ to 15. The difference in the two energies of reaction was $E_D - E_H = 700$ to 900 cal/mole. The mechanism of the recombination is discussed. (K.S.W.)

7402 VINYL ANION. II. Arnett, J. F.; Walborsky, H. M. (Florida State Univ., Tallahassee). J. Org. Chem.; 37: No. 23, 3678-83(17 Nov 1972).

The exchange and racemization reactions of 2,2,4,6,6-pentamethylcyclohexylideneacetophenone (1) with sodium methoxide in methanol were investigated. The ketone 1 exhibits only a moderate degree of retention of optical activity (30% at 50°), $k_e/k_r = 1.43$. This contrasts with the high degree of retention (>99% at 50°) observed with the corresponding 2,2,4,6,6-pentamethylcyclohexylideneacetonitrile (2). On the basis of primary hydrogen−deuterium and deuterium−tritium isotope effects, it is suggested that in both the base-catalyzed exchange and racemization reactions of 1 the rate-determining step is proton abstraction. Both (−)-1 and its precursor (−)-2,2,4,6,6-pentamethylcyclohexylideneacetic acid [(−)-3] were tentatively assigned the R configuration on the basis of their Cotton effects. (auth)

7403 SYNTHESIS AND INFRARED SPECTRA OF ^{15}N LABELED 3-METHYL-2-BENZOTHIAZOLINONE HYDRAZONES AND RELATED COMPOUNDS. Bartsch, R. A.; Huenig, Siegfried; Quast, Helmut (Univ., Wuerzburg, Ger.). J. Org. Chem.; 37: No. 23, 3604-7(17 Nov 1972).

The syntheses of 3-methyl-2-benzothiazolinone hydrazone-1-^{15}N (1a) and -2-^{15}N (1b), 2-imino-^{15}N-3-methylbenzothiazoline (2a), N-(3-methyl-2-benzothiazolinylidene)benzamide-^{15}N (6a), 3-methyl-2-(nitrosimino-imino-^{15}N)benzothiazoline (7a), and 3-methyl-1-(nitrosimino-nitroso-^{15}N)benzothiazoline (7b) are reported. Infrared spectral studies of 1a, 1b, 2a, 6a, 7a, and 7b and the corresponding unlabeled compounds allow for the assignment of several absorption bands. (auth)

7404 NUCLEAR MAGNETIC DOUBLE RESONANCE STUDIES OF THE EFFECT OF DEUTERIUM SUBSTITUTION UPON $^1J(^{31}P-H)$ IN DIMETHYL PHOSPHITE. McFarlane, W.; Rycroft, D. S. (Polytechnic, London). Mol. Phys.; 24: No. 4, 893-5 (Oct 1972).

Two groups of workers have determined $^1J(^{31}P-H)$ and $^1J(^{31}P-D)$ in dimethyl phosphite ($(CH_3O)_2P(O)H$) and its P−deuteriated analogue. The work was done using direct observation of the ^{31}P or ^2D resonances with attendant problems of low sensitivity, and consequently the solutions examined were fairly concentrated. Results are now reported for these systems which were studied by $^1H-\{^{31}P\}$ double resonance experiments so that dilute solutions could be examined. Cyclohexane and methanol were used as solvents. The results indicate that the deuteriated species is the more extensively hydrogen bonded both in solution and in the neat liquid. (UK)

7405 PHYSICAL PROPERTIES OF HEAVY-OXYGEN WATER. ABSOLUTE VISCOSITY OF $H_2^{18}O$ BETWEEN 15 AND 35°C. Kudish, A. I. (Weizmann Inst. of Science, Rehovot, Israel); Wolf, D.; Steckel, F. J. Chem. Soc., Faraday Trans., I; 68: No. 11, 2041-6(1972).

The absolute viscosity of highly enriched heavy-oxygen water, $H_2^{18}O$, was measured at 5°C intervals between 15 and 35°C, using a semi-automatic closed viscometer of the suspended-level type. A linear extrapolation was performed to determine the viscosity of 100% heavy-oxygen water, based on the measured viscosity of natural water and that of a highly enriched heavy-oxygen water sample. The effect of isotope substitution on the viscosity of natural water was analyzed for both $H_2^{18}O$ and $D_2^{16}O$. The viscosity ratio at 25°C for $H_2^{18}O/H_2^{16}O$ is 1.0536, whereas that for $D_2^{16}O/H_2^{16}O$ is 1.2316. (auth)

7406 DECARBONYLATION OF AROMATIC ALDEHYDES ON PLATINUM METAL CATALYSTS. Smolik, J.; Kraus, M. (Inst. of Chemical Process Fundamentals, Prague). Collect. Czech. Chem. Commun.; 37: No. 9, 3042-51(Sep 1972).

Decarbonylation of benzaldehyde and substituted benzaldehydes on palladium, platinum, rhodium, or ruthenium on charcoal at 180°C in gaseous phase was studied in a flow apparatus. Only with platinum catalyst reaction rate depended, and that only slightly, on the kind of substituent. Deuterium exchange in simultaneous reaction of the benzaldehyde deuteriated in the formyl group and the undeuteriated derivative was further studied and kinetic isotope effects in the decarbonylation of C_6H_5CDO were measured. The course of the reaction is discussed and reaction mechanism is suggested. (auth)

7407 DIPOLE MOMENT OF WATER: STARK EFFECTS IN D_2O AND HDO. Brittain, A. H.; Cox, A. P.; Duxbury, A. P.; Hersey, T. G.; Jones, R. G. (Univ. of Bristol, Eng.). Mol. Phys.; 24: No. 4, 843-51(Oct 1972).

The dipole moment of D_2O was determined from Stark effect measurements for the $3_{13} - 2_{20}$ and $4_{41} - 5_{32}$ microwave transitions as 1.857 ± 0.006 and 1.869 ± 0.005 D respectively. A rotational dependence of dipole moment has also been established for HDO through μ_a in the $2_{20} - 2_{21}$ and $5_{32} - 5_{33}$ transitions; μ_a was determined as 0.662 ± 0.001 and 0.644 ± 0.001 D respectively. The total dipole moment for HDO has been determined from the

$3_{21} - 4_{14}$ transition to be 1.85 ± 0.01 D and to lie within 0.1° of the bisector of the HOD angle. High resolution Stark spectroscopy has been performed on the $6_{24} - 6_{15}$ transition of D_2O with improved precision using the 337 μm emission line of the HCN laser. This experiment has confirmed the dipole results from the microwave work and the frequency of the $6_{24} - 6_{15}$ transition in D_2O has been determined as 890 395 ± 3 MHz. The slight increase of dipole moment with deuteration is consistent with the dipole moment for H_2O determined from the dielectric constant. This increase is discussed for the vibrational ground state (as for ammonia) in terms of anharmonicity in the bending vibration. The change of μ with rotational transition is interpreted in terms of large changes in molecular geometry for certain rotational states due to centrifugal distortion. (auth)

7408 KINETIC ISOTOPE EFFECTS OF HYDROGEN EXCHANGE IN TRICARBONYLCYCLOPENTADIENYLMANGANESE AND DICARBONYLCYCLOPENTADIENYL(TRIPHENYLPHOSPHINE)MANGANESE. Yakushin, F. S.; Setkina, V. N.; Kislyakova, N. V.; Kursanov, D. N.; Shatenshtein, A. I. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 2, 316-22(Feb 1972). (In Russian).

The isotope effects were measured for hydrogen exchange with an acid (acetic and trifluoroacetic acid) and tricarbonylcyclopentadienylmanganese (CPM) and dicarbonylcyclopentadienyl-(triphenylphosphine)manganese. The same mechanism applies which is valid for hydrogen exchange in aromatic compounds. In the case of isotope exchange of hydrogen with CPM when catalyzed by base, the protophilic mechanism previously postulated for ferrocene is applicable. (K.S.W.)

7409 MASS SPECTROMETRIC STUDY OF NEGATIVE IONS FORMATION BY ELECTRON IMPACT ON METHYLAMINE AND ITS DEUTERATED DERIVATIVES. Hubin-Franskin, M. J.; Collin, J. E. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 40: No. 9-10, 502-17(1971).

The formation of negative ions by electron impact on methylamine and CD_3NH_2 at low pressure was studied as a function of electron energy using a mass spectrometer. The simultaneous study of CD_3NH_2 confirmed the CH_3NH^- structure for the CNH_4^- ions and allowed elucidation of dissociative electron attachment and ion pair processes leading to H^-. Important isotopic effects were observed for the H^- ions and for the NH_2^- ions of which the intensity decreases from CD_3NH_2 to CH_3NH_2 and then to CH_3ND_2. A minimum value of −0.7 eV is proposed for the electron affinity of the CH_3NH radical. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstract 7542.

7410 APPLICATION OF THE HAMMETT EQUATION TO NONAROMATIC UNSATURATED SYSTEMS. XII. REACTIVITY AND PHYSICAL PROPERTIES OF THE ETHYNYL PROTON. Charton, Marvin (Pratt Inst., Brooklyn). J. Org. Chem.; 37: No. 23, 3684-7(17 Nov 1972).

Data for rates of hydrogen–deuterium and hydrogen–tritium exchange in substituted acetylenes, equilibrium constants for complex formation between substituted acetylenes and diethyl acetamide, CH stretching frequencies in the infrared spectra of substituted acetylenes, and chemical shifts of substituted acetylenes were correlated with the extended Hammett equation, $Q_X = \alpha\sigma_{I,X} + \beta\sigma_{R,X} + h$. Of the 16 sets correlated with the extended Hammett equation, 14 gave statistically significant results. The correlations clearly demonstrated that the resonance effect is in all cases an important and, in some, the predominant component of the electrical effect. (auth)

7411 CONVENIENT DEUTERIUM EXCHANGE TECHNIQUE. Watson, J. M.; Tanner, A. R.; Roberts, R. M. (Univ. of Texas, Austin). J. Org. Chem.; 37: No. 23, 3743-4(17 Nov 1972).

A mild deuterium exchange technique was developed that capitalized on the procedure of Pasto and Meyer [J. Org. Chem. 33, 1257 (1968)], which makes ethanol-O-d_1 easily and economically available as a source of exchangable deuterium. The compound to be deuterated is dissolved in an appropriate excess of ethanol-O-d_1 and a catalytic amount of sodium metal is added. The resulting solution is stirred at room temperature overnight, the ethanol is removed in vacuo, and a second portion of ethanol-O-d_1 is added. After exchange with two or three portions of ethanol-O-d_1 has been carried out in this way, an amount of acetyl chloride just sufficient to destroy the sodium ethoxide present is added. The resulting ethyl acetate is removed along with ethanol-O-d_1 by flash distillation, and the remaining material is distilled to effect isolation of the desired deuterated product. (D.H.M.)

7412 SELF-DIFFUSION OF CHLORIDE IONS IN NICKEL DICHLORIDE CRYSTALLITES AND AN ISOTOPIC EXCHANGE REACTION BETWEEN CHLORINE GAS AND THE CRYSTALLITES. Sensui, Y. (Rikkyo Univ., Yokosuka, Japan). Bull. Chem. Soc. Jap.; 45: No. 9, 2677-83(Sep 1972).

The self-diffusion of chloride ions in the bulk of nickel dichloride crystallites was studied in the temperature range of 180 to 340°C in a carefully evacuated vacuum system; the isotopic exchange reaction between gaseous chlorine and the crystallites was also studied. The activation energy for the migration of chloride ions was determined to be 1.01 eV (=23.3 kcal/mol). The exchange reaction proceeded with activation energies of 3.6 and 9 kcal/mol for the active and the less-active part of the surface first layer, 13 and 16 kcal/mol for the active and the less-active one of the second layer, and 21 kcal/mol for the third layer. (These activation energies converge to the value of the self-diffusion in the bulk.) The Θ-rule nearly holds good in the present case. (auth)

7413 VARIATION OF THE SINGLE-STAGE ISOTOPE SEPARATION FACTOR IN ADSORPTION ON DIFFERENT FORMS OF CATION EXCHANGER PRODUCED BY ION EXCHANGE. Kuznetsova, E. M.; Salimova, K. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 4, 581-2(Apr 1972).

Translated from Zh. Fiz. Khim.; 46: No. 4, 1002-3(Apr 1972).

The variation of the logarithm of the single-stage separation factor with the argument $x/r_1^2+(1-x)/r_2^2$, where r_1 and r_2 are the crystallographic radii of the cations in the cation exchanger and x the equivalent fraction of one of them, was established and explained using experimental data for the separation of hydrogen and nitrogen isotopes on different forms of cation exchanger produced by ion exchange. (auth)

7414 ANALYSIS OF THE SEPARATION PROCESS ON THE BASIS OF EXPERIMENTAL DATA. I. THE NON-EQUILIBRIUM [ISOTOPE] SEPARATION FACTOR. Basov, Yu. G.; Panchenkov, G. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 4, 504-5(Apr 1972).

Translated from Zh. Fiz. Khim.; 46: No. 4, 871-3(Apr 1972).

Analytical methods are presented for the investigation of isotope separation processes using experimental data. Formulas were derived for the calculation of the nonequilibrium separation factors in such cases. (auth)

7415 ^{18}O-RICH OXYGEN FROM LAND PHOTOSYNTHESIS. Dongmann, G.; Foerstel, H.; Wagener, K. (Kernforschungsanlage, Juelich, Ger.). Nature (London) New Biol.; 240: No. 99, 127-8(22 Nov 1972).

A brief discussion is presented of the contribution of photosynthesis in transpiring leaves to the excess of ^{18}O in the atmosphere, compared with seawater. Results are presented of the enrichment in ^{18}O in plant leaves, plotted as a function of the time of day. Species studied were the European Beech and Oak and a tropical species with a high transpiration rate, Spathodea campanulata. Indications were that the highest transpiration rate should result in the highest concentration of heavy water in the leaves, where the difference in the vapor pressure of $^{16}OH_2$ and $^{18}OH_2$ concentrates the heavy molecules in their stationary water content. Quantitative interpretation was open to doubt, because it was not sure that the lowest ^{18}O values, observed at night, corresponded to the equilibrium isotope effect due to the vapor pressure difference. (UK)

7416 HYDROGEN ISOTOPE EXCHANGE IN TYROSINE AND TRYPTOPHAN. Holt, L. A.; Milligan, B. (CSIRO, Melbourne). Photochem. Photobiol.; 16: No. 6, 511-13(Dec 1972).

A study was made to determine whether tritium-hydrogen exchange at the 3- and 5-positions of tyrosine was partial or complete under conditions normally used for the acid hydrolysis of labeled proteins. The number of H_2 atoms/tyrosine molecule that exchanged with tritium after treatment with tritiated HCl (5.4M) at 105°C ranged from 1.86 to 1.91. Treatment time ranged from 1 to 68 hr. At 25°C, and with a treatment time of 72 hr, the value for the exchangeable H_2 atoms/tyrosine molecule was 0.12. The results confirmed earlier ones (Martin and Morlino, Science, 150, 493 (1965)) that any tritium labels introduced at the 3- or 5-position of tyrosine residues in proteins would escape detection by the analytical procedure of Miller et al. (Photochem. Photobiol–14, 577 (1971)). Results also showed that 90% of the tritium labels introduced during ultraviolet irradiation of tyrosine in tritiated water were situated at the 3- or 3- and 5- positions. It was also demonstrated that the aromatic hydrogen atoms of tryptophan exchange with solvent protons during treatment with hot acid. (UK)

Feed Materials Processing

Refer also to abstracts 7554 and 7555.

Radiation Chemistry

Refer also to abstracts 7465, 7479, 7720, and 8918.

7417 (COO-3118-3) EFFECTS OF MERCAPTANS AND DISULFIDES ON PHOTOCHEMICAL AND HIGH ENERGY RADIATION INDUCED REACTIONS. Progress Report, November 1, 1971–October 31, 1972. Cohen, S. G. (Brandeis Univ., Waltham, Mass. Dept. of Chemistry). [nd]. Contract AT(11-1)-3118. 19p. Dep. NTIS.

For interaction of excited carbonyl compounds with potential electron donors, a quantitative relationship is proposed between log of the rate constant, log k_{ir}, and the ionization potential of the donor, $I.P._D$, and the reduction potential, $E(A^-/A)$ and triplet energy of the acceptor, $^3\Delta E_{0,0}$. Linear relationships are observed log $k_{ir} \sim -^3\Delta E_{0,0} + I.P._D - E(A^-/A) + C$ between log k_{ir} and $I.P._D$ for benzophenone and fluorenone interacting with a variety of donors, and between log k_{ir} and $(-\Delta E_{0,0} - E(A^-/A))$ for interaction of triethylamine with a series of carbonyl compounds of varied triplet configuration. ^{60}Co γ-radiolysis of dilute aqueous methyl acetate leads to radicals, $CH_3C(OH)CH_3$(I), $\cdot CH_2CO_2CH_3$(II), and $CH_3CO_2CH_2\cdot$ (III), and to products of their combination, ethylene diacetate (EDA), methyl acetoxypropionate (MAP), dimethyl succinate (DMS), acetonyl acetate (AcA), and to acetic acid. G values were determined. Fentons reagent also leads to EDA, MAP, and DMS. Presence of 0.002 M mercaptan eliminates the products of radical combination, leads to acetaldehyde presumably by reduction of radical I. (auth)

7418 (COO-3435-6) MICROWAVE-OPTICAL DOUBLE RESONANCE SPECTROSCOPY. Progress Report, February 1, 1972–January 31, 1973. Pratt, D. W. (Pittsburgh Univ., Pa. Dept. of Chemistry). 1 Nov 1972. Contract AT(11-1)-3435. 31p. Dep. NTIS.

Research progress is reported on the application of microwave-optical double resonance (MODR) techniques to the study of the structural properties of the phosphorescent triplet states of organic molecules. It is shown for the first time how it is possible to obtain the signs and magnitudes of the zero field parameters of the triplet state by careful analysis of the temperature dependence of the MODR spectrum of 1,2,4,5-tetrachlorobenzene (TCB) in durene. Measurements were completed of the anisotropy of the g and zero field tensors of both TCB and the corresponding tetrabromobenzene (TBB) derivative. Preliminary results of similar measurements on several other systems are also described, including p-dibromobenzene in naphthalene, 2,3-dichloroquinoxaline in TCB, and benzophenone in various hosts. In addition, measurements of the magnetic field dependence of the phosphorescence lifetimes of TCB and TBB in durene are presented, and it is shown how this information can be used to determine the field dependence of electron spin lattice relaxation in the absence of microwaves. Classes of radicals, produced by x irradiation of adamantane containing cycloalkanes, cycloketones, and aromatics, investigated include cycloalkenyl, substituted allyl, β-carbonyl, and aromatic free radicals. These measurements include the determination of kinetic and thermodynamic parameters for the interconversion between the different conformations of several cyclohexanonyl radicals and the ^{13}C and ^{17}O hyperfine splittings of the cyclohexanonyl radical. Preliminary results on the application of MODR techniques to the electronically-excited doublet states of free radicals are also described. (auth)

7419 (ORNL-TM-3996) EFFECT OF IRRADIATION ON THE EPR AND OPTICAL ABSORPTION SPECTRA OF Li_2BeF_4. Pigg, Jay Cee; Weeks, R. A. (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 21p. Dep. NTIS.

The effect of ^{60}Co and reactor irradiation on the electron paramagnetic resonance spectrum and optical absorption spectrum of Li_2BeF_4 are qualitatively the same. Two sets of electron magnetic resonance peaks are observed. One set is associated with the crystals present in the sample; the other set seems to be associated with the glassy part of the sample. Three broad optical absorption bands are observed. One band centered at 2.4 eV, another at 5.0 eV, and a third is located near one of the band edges. Thermal annealing of the sample or irradiation at greater than 112°C produces a step in the optical absorption spectrum at 5.5 eV. After an anneal at 450°C for 40 minutes, the irradiation-induced changes are essentially removed except for three weak components in the electron magnetic resonance spectrum and an absorption peak at 2.4 eV in the optical absorption spectrum. The residual electron magnetic resonance peaks are well resolved; two of them are orientation-dependent. (auth)

7420 (ORO-3606-28) PRINCIPAL PROCESSES IN THE RADIOLYSIS OF GASES BY HIGH ENERGY ELECTRONS AND FISSION RECOILS. Annual Progress Report, October 1, 1971–September 30, 1972. Meisels, G. G. (Houston Univ., Tex. Dept. of Chemistry). Sep 1972. Contract AT(40-1)-3606. 54p. Dep. NTIS.

Progress is reported on an investigation of the formation and reactions of intermediates produced on irradiation of gases with high energy electrons and with fission recoils. A chemical kinetic approach was employed in which products formed on irradiation are analyzed and the variation of their yields with experimental conditions and their dependence on the concentration of additives are used as diagnostic and interpretative tools. In fission recoil experiments, it was shown that reactions second-order in reactive intermediates become important at the highest densities accessible at this time (ca. 0.1 g/cm^3) in the recoil track. For free radicals, it was possible to derive an "effective" track volume without recourse to diffusion kinetics; this volume appears to be considerably smaller than that estimated from superficial range-energy relationships. Such a correlation has not yet been achieved for ionic intermediates because of the greater complexity of the reaction mechanism, but deviations from behavior predicted for the absence of tract effects clearly indicate that ionic reactions, even in the first few steps, are affected by the high radiation density. Radiolysis using high energy electrons has concerned itself mostly with a clarification of the mechanism of ethylene ion reactions, and with a method for the assessment of the yields of vinyl and acetylene ion. Photolyses at 123.5 nm have addressed themselves to the question of the dependence of the most important neutral fragmentation processes in ethylene on energy and pressure, and the mass spectrometric aspects of the program have emphasized the development of a better understanding of the technique at a pressure of 1 torr (0.133 kNm^{-2}) and its applicability to the determination of ionic heats of reaction. Precise determinations of average energies required for ion pair formation in gases demonstrated that we could not provide conclusive evidence on the contribution of autoionization to the ionization yield in alcohols, and yielded a precise and reliable set of W values for a series of alkanols. Lastly, ethyl ion was shown to undergo an intramolecular hydride transfer efficiently, with an activation energy of less than 2 kcal/mole, suggesting that within this limit the bridged structure is thermodynamically equivalent to the classical ethyl ion structure. (auth)

7421 (PRNC-159) GAMMA RADIOLYSIS OF HETEROCYCLIC MOLECULES. Progress Report 6. Arce, R.; Eberhardt, M.; Grimison, A.; Simpson, G. A. (Puerto Rico Nuclear Center, Mayaguez). Sep 1972. Contract AT(40-1)-1833. 35p. Dep. NTIS.

Research progress is reported in the following areas: reactions of solvated electrons with uracil and cytosine; recombination luminescence after photolysis or γ irradiation; electron spin resonance studies of indole photolysis; and flash photolysis of heterocyclic molecules in solution. (D.H.M.)

7422 (SC-T-722563) CHANGE IN THE RADIATION STABILITY OF LEAD AZIDE USING ADDITIVES. Zakharov, Yu. A.; Ryabykh, S. M. Translated for Sandia Labs., Albuquerque, N. Mex., from Izv. Tomsk. Politekh. Inst.; 176: 107-10(1970). 8p. Dep. NTIS.

A study was made of the x-radiolysis of pure lead azide and the effects of solid additives, as well as of additives that form solid solutions with lead azide, on the radiation stability of lead azide. Additives with small values of the electron work function, CdO and ZnO, speed up the radiolysis and Ni_2O_3 and CoO significantly slow down the radiolysis. The presence of Ag^+ in the PbN_6 crystal lattice speeds up the radiolysis and the presence of Cu^{2+} slows down the radiolysis. (D.H.M.)

7423 DISTRIBUTION OF THE ENERGY OF SECONDARY ELECTRONS AND TRACK EFFECTS. THE ENERGY SPECTRUM OF SECONDARY ELECTRONS. Kaplan, I. G.; Skurat, V. E. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 3, 224-35(1972).

Translated from Khim. Vys. Energ.; 6: No. 3, 252-65(1972).

The spectra of Compton electrons and photoelectrons in the range from 0 to 0.1 MeV calculated by the Monte Carlo method for the case of complete degradation of ^{60}Co γ quanta in water are shown. The bulk of the Compton electrons is expelled in the region of energies less than 0.01 MeV. The spectrum of the photoelectrons has a maximum in the region of energies less than 0.01 MeV. The spectrum of the photoelectrons has a maximum in the energy region of 0.03 to 0.04 MeV and falls to zero as soon as E < 0.02 MeV. The expelled electrons consume their energy in processes of excitation and ionization of the molecules of the medium. Characteristic energy losses of electrons in solid films and multicomponent mixtures were also studied. The influence of dose rate in radiation chemistry is considered on the basis of uniform distribution of those radicals that do not recombine in the track. (53 references) (M.C.G.)

7424 EPR STUDY OF FREE RADICALS IN GAMMA-IRRADIATED COTTON CELLULOSE. Khamidov, D. S.; Azizov, U. A.; Milinchuk, V. K.; Usmanov, Kh. U. Dokl. Akad. Nauk Uzb. SSR; No. 4, 34-5(1971). (In Russian).

Cotton cellulose was hydrolyzed in 2.5% H_2SO_4 for 4 hr, irradiated with a ^{60}Co source, and examined with EPR equipment. Cellophane was boiled in distilled water for 5 hr and similarly irradiated and examined. The radiochemical yields of free radicals found by the EPR method for control cellulose, hydrolyzed cellulose, and cellophane at 77, 193, and 300°K indicated that the rise in temperature increased the number of free radicals in the two cellulose samples, but not in cellophane. (K.S.W.)

7425 PULSE RADIOLYSIS OF CONCENTRATED AQUEOUS SOLUTIONS OF POTASSIUM THIOCYANATE. Zhestkova, T. P.; Pikaev, A. K.; Spitsyn, V. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 204: No. 5, 1147-50(11 Jun 1972). (In Russian).

Aqueous solutions of KCNS in concentrations from 10^{-3} to 9M were given 2.3×10^{-6} sec pulses of 5-MeV electrons from a linear accelerator. The solutions had previously been saturated with O_2 or Ar. A fast-operating spectrophotometer was used to record the short-lived optical absorption of the radiolysis products. The ion-radical $(CNS)_2^-$ was commonly observed; its G-value was 4.2/100 eV. The optical density of the solutions was studied as a function of the concentration of KCNS. As a function of time the disappearance of optical absorption was a second order process in dilute solutions. (K.S.W.)

7426 RADIATION-CHEMICAL SYNTHESIS OF DESOXY-NUCLEOSIDES. Khenokh, M. A.; Kuzicheva, E. A.; Evdokimov, V. F. (Inst. of Cytology, Leningrad). Dokl. Akad. Nauk SSSR; 204: No. 5, 1265-8(11 Jun 1972). (In Russian).

Radiation-chemical synthesis was attempted from solid nitrogen bases and desoxyribose under conditions that approximated those on the primordial earth. Mixtures of dry powdered 2-desoxy-D-ribose, nitrogen bases, a metal oxide, and Ar purified of O_2 were irradiated by a ^{60}Co source. Thin-layer chromatography of solutions of the irradiated mixtures aided in identifying milligram quantities of desoxyadenosine (or other desoxynucleosides). Ribose was apparently converted into desoxyribose. Five metallic oxides could be arranged in order of their ability to suppress such synthesis: $Fe_2O_3 > ZnO = CuO > SiO_2 > TiO_2$ = adenine + desoxyribose without oxide. (K.S.W.)

7427 DOSE-RATE EFFECT IN RADIATION CHEMISTRY REACTION. 1. Yasukawa, Tamio; Nakanishi, Hiromasa; Tamura, Saburo; Takahashi, Tohru (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 1, 133-5(Sep 1971). (In Japanese).

In radiation chemistry reactions the kind and yield of products are different for different dose rates, even if total dose is equal. This fact is recognized in several experiments on the graft reaction to polymers. The cause is supposed to be very slow diffusion of the polymers. Polyethylene was irradiated in air with an electron beam dose of 3 Mrad at dry-ice temperature. The dose rate was approximately 0.1 Mrad/sec. A part of the alkyl radical was changed to peroxy radical, being combined with oxygen. Under the conditions of the experiment, the quantity of the produced peroxy radical was ca. 10^{-6} spin/g, PE, and the G-value was 1 or so. When irradiated with γ rays under the same conditions except with a dose rate of 1.4×10^5 r/h, accurate quantitative determination was difficult because of weak ESR signal. In infrared absorption spectra of the polyethylene, the difference between electron and γ ray irradiation is significant. (Japan)

7428 RADIATION POLYMERIZATION OF SINGLE CRYSTALS OF TETRAFLUOROETHYLENE AND STEPWISE POST-POLYMERIZATION OF POLYCRYSTALLINE TETRAFLUOROETHYLENE UNDER ISOTHERMAL CONDITIONS. Chuiko, K. K.; Bruk, M. A.; Abkin, A. D.; (and others). Vysokomol. Soedin., Ser. B; 14: No. 9, 635-6(Sep 1972). (In Russian).

Single crystals of tetrafluoroethylene (TFE) were grown from a melt at 138°K over a period of ~50 hr, and γ-irradiated at 77°K to induce polymerization. EPR spectra indicated an anisotropic growth of polymer chains in crystalline TFE, and evidence was detected of "stepwise" solid-phase postpolymerization at 138 ± 0.5°K. (K.S.W.)

7429 REACTION OF ATOMIC NITROGEN WITH PROPENE. Havel, J. J.; Skell, P. S. (Pennsylvania State Univ., University Park). J. Org. Chem.; 37: No. 23, 3744-5(17 Nov 1972).

A study was made of the solution phase reaction of propene with atomic nitrogen, produced by microwave discharge through molecular nitrogen. The nitrogenous products from this reaction are HCN (55.4%), acetonitrile (4.9%), and acrylonitrile (0.17%). The reaction of atomic nitrogen with liquid propene closely parallels the gas phase reaction. There is little resemblance between these reactions and the reactions of the reactive species produced by the γ radiolysis of propene in liquid nitrogen. The active species in the latter reactions cannot be ground state atomic nitrogen. (D.H.M.)

7430 STABLE PARAMAGNETIC SPECIES IN NATURAL STRONTIUM SULFATE CRYSTALS. Matsuzaki, T.; Setaka, M.; Gromov, V. V.; Kwan, T. (Tokyo Univ.). Bull. Chem. Soc. Jap.; 45: No. 9, 2773-5(Sep 1972).

Natural strontium sulfate crystals were found to show complex ESR spectra without any special irradiation. The spectra were classified into three groups, A, B, and C; the thermal and photochemical behavior of each group was distinguished from that of the others. It was proposed that Group B originates from SO_3^- radicals, and Groups A and C were tentatively interpreted as due to lattice defects (F-center and V-center). (auth)

7431 PRODUCTION OF FREE RADICALS FROM ADAMANTANE BY HIGH ENERGY IRRADIATION. Filby, W. G.; Guenther, K. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 27b: No. 11, 1289-93(Nov 1972).

The nature and properties of radicals produced by the action of electron and γ radiation on adamantane were investigated. Radicals produced by irradiation at 77°K are stable to around room temperature, while irradiation at the latter temperature yields well resolved spectra of species stable to about 130°C. The significance of the latter, assigned as the 1-adamantyl radical, in the formation of trapped radicals is discussed. (auth)

7432 ENERGY PARTITION IN THE γ-RADIOLYSIS OF GASEOUS $H_2S + N_2$, $H_2S + Ar$, AND $H_2S + Xe$ MIXTURES. Ahmad, M.; Huyton, D. W.; Woodward, T. W. (Univ. of Salford, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 10, 1857-65(1972).

Ionization measurements in $H_2S + N_2$, $H_2S + Ar$, and $H_2S + Xe$ mixtures are used to determine apparent stopping power ratios for the mixtures, or "energy partition parameters." The values found for $H_2S + N_2$, $H_2S + Ar$, and $H_2S + Xe$ are 0.20, 0.95, and 3.60 respectively, as compared to the calculated values of 0.82 0.95, and 2.46. In $H_2S + Ar$ mixtures a "Jesse effect" is observed that increases the ion yield by 2 units, this effect being quenched out between stopping power fractions Z = 0.2 to 0.4. Measurement of sulphur yields in $H_2S + N_2$ mixtures enables an energy partition parameter of 0.5 to be evaluated. The difference from the value obtained by ionization measurements being explained by a small "Jesse effect." In $H_2S + Ar$ mixtures the sulphur yield G(S) was always >G(S) = 7.0 found in pure H_2S and approached values as high as 24. The sulphur yield also increased between Z = 0.2 and 0.4 by twice the decrease in the ion yield. G(S) in $H_2S + Xe$ mixtures never rises above 7.0, and the values can be justified by energy transfer from $Xe^*(G \simeq 5.0)$ to H_2S to give $H_2 + S^*$, where S^* is not a ground state $S(^3P)$ atom. No such simple mechanism will explain the results in $H_2S + Ar$ mixtures. Butadiene was used as SH and $S(^3P)$ scavenger, and the ratio of scavengeable to non-scavengeable sulphur in $H_2 + Ar$ mixtures is similar to that in H_2S, i.e., ~13. In $H_2S + Xe$ mixtures this ratio is ~3 to 4, and is explained by production of excited S atoms (S^*), which react with H_2S to give H_2 and S_2. (auth)

7433 CALCULATION OF EFFICIENCY AND OPTIMAL PARAMETERS OF CHEMONUCLEAR PLANTS. Dzantiev, B. G.; Krasin, A. K.; Nichipor, G. V.; Kazazyan, V. T.; Savushkin, I. A. At. Energ. (USSR); 33: No. 4, 803-8(Oct 1972). (In Russian).

A method of calculating the efficiency of chemonuclear plants is described. By means of this method, the optimal parameters of an experimental chemonuclear plant were obtained and the possibility of industrial realization of hydrazine synthesis on the basis of a chemonuclear reactor evaluated. (auth)

7434 FORMATION OF MOLECULAR HYDROGEN BY RADIOLYSIS OF ALIPHATIC SULFIDES, THIOCYANATES, AND THIOLS. Nanobashvili, E. M.; Dapkviashvili, A. G.; Tushurashvili, R. G. (Inst. of Inorganic Chemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 68: No. 2, 353-6(Dec 1972). (In Russian).

The process of the formation of molecular hydrogen was investigated by low-temperature radiolysis of aliphatic sulfides, thiocyanates, and thiols and a correlation between the values of the yields of radical products and molecular hydrogen was established. Attempts are made to determine the role of the ion- and excited-states in the formation of molecular hydrogen by low-temperature radiolysis of these compounds. (auth)

7435 RADIOLYSIS OF TROPANE ALKALOIDS IN AQUEOUS SOLUTIONS. Chakchir, B. A.; Grachev, S. A.; Ryabykh, L. D. (Inst. of Nuclear Physics, Leningrad). Khim. Prir. Soedin.; No. 3, 401(1972). (In Russian).

Yields of decomposition products obtained from irradiation of alkaloids do not depend on the concentration of the irradiated solution. Increasing the dose of radioactivity leads to a lower yield. The breakdown products obtained from the irradiation of alkaloids

show no biological activity. Tropine and tropic acid were identified among the products obtained from irradiated atropine. (JPRS)

7436 RADIATION CHEMISTRY OF HEXAMETHYLBENZENE. **Roder, M. (Central Research Inst. for Physics, Budapest). Acta Chim. Acad. Sci. Hung.; 73: No. 4, 443-52(1972).**

The ^{60}Co γ radiolysis of hexamethylbenzene (HMB), a fully substituted benzene derivative, was investigated. The reaction products were studied by gas chromatography. The radiation chemical yields of the main products and of HMB disappearance were determined as a function of the total dose, dose rate, phase, temperature, and scavengers. On the basis of these results, it is suggested that H_2 is formed by some molecular process, irrespective of phase and temperature, while methane and pentamethylbenzene are produced both in molecular and in radical reactions. Comparison of the number of HMB molecules consumed in the formation of gaseous products, calculated considering the yields and modes of formation of the gases, with the directly measured yield of HMB disappearance shows that hydrogen atom addition to the aromatic ring of HMB cannot be an important process. (auth)

7437 MECHANISM OF RADIOLYSIS OF AQUEOUS SOLUTIONS OF DNA. **Zakatova, N. V.; Sharpatyi, V. A. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 200: No. 6, 1378-81(21 Oct 1971). (In Russian).**

Solutions of DNA were subjected to 6 to 20 kR of radiation and the resulting accumulations of radiolysis products were measured: malondialdehyde, NH_3, and H_2O_2. Solutions of 2-deoxyribose were similarly irradiated in order to elucidate the mechanism of malondialdehyde production from DNA: the 2-deoxyribose groups in DNA radiolyze to yield malondialdehyde. The mechanisms of NH_3 and H_2O_2 production are discussed. (K.S.W.)

7438 EFFECT OF X RADIATION ON THE DECOMPOSITION OF SOLID SOLUTIONS OF NaCl–AgCl. **Suslova, V. N.; Zavadovskaya, E. K.; Yarosh, E. M.; Zvinchuk, R. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 129-32(1972). (In Russian).**

X radiation retarded the decomposition of supersaturated solid solutions of NaCl–AgCl, the retardation being accompanied by the formation of metallic Ag particles in the lattice. A possible cause of the retardation of decomposition is the formation of colloidal Ag particles during the irradiation process. (K.S.W.)

7439 FORMATION OF ICE IN WATER AND SOLUTIONS. III. NUCLEATION OF ICE BY THE RADIOLYSIS OF WATER. **Rozental, O. M. (Sverdlovsk State Pedagogic Inst., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 4, 559-60(Apr 1972).**

Translated from Zh. Fiz. Khim.; 46: No. 4, 971-2(Apr 1972).

Samoilov's theory of hydration is used to show how increasing the proportion of dissociated molecules, in particular by the action of ionizing radiation, facilitates the formation of ice in a supercooled liquid phase. (auth)

7440 GAMMA-RADIOLYSIS OF GASEOUS 1,3-BUTADIENE. YIELDS OF DECOMPOSITION PRODUCTS. **Niedzielski, J.; Gawlowski, J. (Univ., Warsaw). Radiat. Eff.; 16: No. 1-2, 75-81(Sep 1972).**

The radiolysis of gaseous 1,3-butadiene was investigated using ^{60}Co γ-rays. The yields of C_1 to C_4 hydrocarbons are reported for both scavenged and unscavenged systems. Ion and electron scavengers have no appreciable effect on the formation of products. The effects of pressure, in the range 7 to 500 torr, on the yields of major products: ethylene, acetylene, and vinylacetylene, are evaluated. These products result mainly from the dissociation of two distinct species of excited 1,3-butadiene molecules, the lower limits of the yields of these species being estimated as 2.5 and 1.2, respectively. The yields of the major radical species: methyl, vinyl, and ethyl radicals are derived from hydrogen sulfide scavenging experiments. (auth)

7441 FORMATION OF POLYMER COATINGS ON SUBSTRATES. **Williams, T.; Westwood, H. J. (to British Iron and Steel Research Association). British Patent 1,286,824. 23 Aug 1972. Filed 29 Aug 1968.**

A method is described for applying polymer coatings on metal substrates, such as tin plate. The coating material is deposited on the substrate and crosslinked or polymerized by vacuum irradiation with electrons, x rays, or γ rays. The irradiation dose should not exceed 1000 MR and if an electron beam is used the electron energy should be at least 10 keV. The coating material may be an epoxy resin, and may be applied to the substrate by electrophoresis, powder coating, or liquid coating; or the material may be an oil. Hot metal coating may also be employed when the material is heat flowable, to give a uniform coating. Extrusion coating may also be employed Examples are described. (UK)

7442 ELECTRON SPIN RESONANCE SPECTRUM OF RADICALS IN γ-IRRADIATED TRIMETHYL PHOSPHITE: $P(OMe)_4$, $HP(OMe)_3$, $P(OMe)_3P-P(OMe)_3^+$, AND $H_2COP(OMe)_2$. **Symons, M. C. R. (Univ. of Leicester, Eng.). Mol. Phys.; 24: No. 4, 885-7(Oct 1972).**

Electron spin resonance spectra of solids that have been exposed to high energy radiation are either so poorly resolved that interpretation is impossible, or comprise features for one or two distinct radicals only. In the author's experience the spectrum for γ-irradiated trimethyl phosphite is unique in showing clear features for at least five different radicals. Suggestions are offered for the identification of these radicals and for their structures. A possible mechanism for damage is also indicated. (auth)

7443 NOVEL CROSSLINKED POLYMER. **Charlesby, A. British Patent 1,287,143. 31 Aug 1972. Filed 30 Jan 1969.**

It is stated that it has been found that certain vinyl monomers can act as very effective crosslinking agents for thermoplastic polyolefins and can be used to cross link these polymers at much lower monomer concentrations and using much lower radiation doses than in previously known methods. No substantial grafting of the monomer to the polymer occurs and there is little or no direct cross linking of the polymer. In the process described the thermoplastic polyolefin is subjected to radiation or an electrical gas discharge, to a dosage of not more than 1.5 MR, and preferably as low as 0.1 MR, or its equivalent, in the presence of acrylic and/or methacrylic acid, or their alkali metal salts. The process may also be applied to poly(vinyl alcohol). The vinyl monomer should be present in a concentration such that the total weight increase of polymer is not greater than 2 to 8% of the original polymer, and the irradiation is preferably carried out in the presence of a chain limiting agent, such as CCl_4. The polyolefin may be polyethylene, polypropylene or poly(4-methyl-1-pentene), and a number of examples are described. The polyolefin may contain filler material, reinforcing powder, metallic inserts, or glass fibers. Acrylamide or methacrylamide may also be incorporated into the polymer. The polymer may be shaped before irradiation, and the crosslinked polymer may be applied to other materials by heating under pressure. Metals may be applied by electroplating, sputtering, evaporation, or electrodeless deposition. Laminates may also be produced with alternate layers of crosslinked polymer and layers of other materials such as metal, wood, glass or synthetic thermoplastic polymer. (UK)

7444 ELECTRON REACTIONS IN VITREOUS AQUEOUS SOLUTIONS OF ELECTROLYTES IRRADIATED BY γ RAYS AT 77°K. **Girina, E. L.; Ershov, B. G. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 2, 278-81(Feb 1972). (In Russian).**

Stabilization of electrons disappears in γ-irradiated glassy aqueous solutions of the ions NO_3^-, NO_2^-, and $[Fe(CN)_6]^{3-}$ which function as electron acceptors. The irradiation was conducted with a ^{60}Co source at 77°K. The mechanism of this phenomenon is discussed, and the corresponding rate constants were determined. Reaction rate constants were measured for the thermalized electrons in alkaline aqueous "glasses" for a series of electron acceptors. (K.S.W.)

7445 UNSTABLE INTERMEDIATES. Pt. 120. ELECTRON SPIN RESONANCE STUDY OF γ-IRRADIATED t-BUTYL CHLORIDE: COUPLING TO β-CHLORINE ATOMS. **Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 11, 1897-1903(1972).**

Two radicals were detected by ESR spectroscopy after exposure of t-butyl chloride (^1H and ^2H) to γ rays at 77°K. One, the t-butyl radical, is well known, but the other, Me_2C-CH_2Cl, probably formed by loss of a methyl hydrogen atom followed by a 1,2-chlorine shift, is novel and shows the following features: (i) the hyperfine coupling to ^{35}Cl and ^{37}Cl nuclei is unusually large (~45 G at 77°K); (ii) the methyl–proton coupling is low (~17 G); (iii) the methylene–proton coupling is extremely small (~5 G). These results suggest not only that the radical is locked in a conformation in which maximum overlap between the carbon 2p-orbital of the radical and the C–Cl σ-bond is achieved, but also that considerable distortion involving movement of the chlorine atom towards the radical center has occurred. (auth)

7446 FREE-RADICAL CLEAVAGE OF THE DISULFIDE BOND (STUDIED BY PULSE RADIOLYSIS). **Shafferman, A. (Hebrew Univ., Jerusalem). Israel J. Chem.; 10: No. 3, 725-33 (1972).**

Reactions of H atoms with glutathione lead rapidly to H + RSSR → RS· + RSH. The first observed product is RS, the spectrum of which is obtained. The spectrum of the RSSR radical

was obtained by direct attack e^-_{aq} on glutathione. The rate constants of these processes were also measured: $k_{e^-_{aq} + RSSR} = (2.7 \pm 0.3) \times 10^9\ M^{-1}\ sec^{-1}$ and $k_{H+RSSR} = (1.0 \pm 0.2) \times 10^{10}\ M^{-1}\ sec^{-1}$. When the OD of RSSR is plotted vs pH a titration curve is obtained. This is due to the protonation of RSSR with a rate constant of $2.6 \times 10^{10}\ M^{-1}\ sec^{-1}$, which is probably followed by a cleavage to RS and RSH. In both cases the RSSHR radical cannot be detected. The spectrum attributed to the RSSHR radical is more likely to be that of RS. (auth)

7447 COMMENTS ON THE NATURE OF THE OXIDIZED FORM OF THE NICKEL DIMETHYLGLYOXIME COMPLEX. Lati, J.; Meyerstein, D. (Nuclear Research Centre, Beersheba, Israel). Israel J. Chem.; 10: No. 3, 735-8(1972).

The pulse radiolytic technique was used to prove that the central nickel atom, in the oxidized form of the nickel dimethylglyoxime complex, is in its trivalent oxidation state. (auth)

7448 RADIATION OXIDATION OF WATER ADMIXTURES IN WATER CONTAINING HUMAN WASTES. Bychkov, N. V.; Kasperovich, A. N.; Krasnoshchekov, V. V.; (and others). Kosm. Biol. Med.; 6: No. 6, 44-7(1972). (In Russian).

A radiation method for purifying water containing human wastes from organic admixtures in the presence of hydrogen peroxide was developed. The effect of radiation dosages on the oxidation of organic admixtures was studied. A toxicological evaluation of regenerated water was performed. (auth)

7449 GRAFT COPOLYMERIZATION OF N-METHYLOL ACRYLAMIDE ONTO WOODY FIBERS AND CELLULOSE PULPS. Sakata, I. (Kyushu Univ., Fukuoka); Senju, R.; Miyata, N. Kobunshi Kagaku; 29: No. 328, 577-82(Aug 1972). (In Japanese).

Grafting of N-methylolacrylamide onto the woody fibers pretreated with peracetic acid (I) readily proceeded without gelation of the reactant by crosslinking of the methylol groups during the course of the polymerization. The initial rate of the grafting was proportional to the square root of peroxide content in the sample pretreated with (I). Apparent activation energy of the grafting was 10.3 kcal/mol. Cellulose pulps were also readily grafted by (I) pretreatment and the apparent activation energy (10.8 kcal/mol) was almost the same as in the case of woody fibers. However, very small amounts of peroxide groups were formed by (I) pretreatment. The woody fibers pretreated with other oxidizing agents, such as hydrogen peroxide or ceric salt, gave only poor yields of graft copolymer, whereas, in the case of cellulose pulps, significant grafting has been obtained. Similar results were found for the grafting by a γ preirradiation technique in air. The strength of the paper made from the grafted cellulose pulps was markedly improved by the heat cure. (auth)

7450 METHOD OF IMPROVING THE TACK OF RUBBERS. Soldatos, A. C. (to Union Carbide Corp.). British Patent 1,286,668. 23 Aug 1972. Filed 22 Oct 1969.

A method is described for improving the tack of natural and synthetic rubbers. The method is quick, in some cases of the order of seconds, and requires no special regard to conditions of temperature and humidity. A "tackifier" is added and the compositions subjected to an electric discharge, ionizing radiation, or non-ionizing radiation. Suitable "tackifiers" are phenolic polymers, such as alkylated phenol formaldehyde resins, p-dodecylphenol formaldehyde resins, phenolated polymers of isoprene, polyisoprane phenolated with p-dodecylphenol, etc., at an amount of at least 1%, and electron irradiation is convenient. Examples are described. (UK)

7451 DOES $e^-_{aq} + H_3O^+_{aq}$ GIVE H ATOMS DIRECTLY? Nielsen, S. O. (Brookhaven National Lab., Upton, NY). Nature (London) Phys. Sci.; 240: No. 97, 21-2(6 Nov 1972).

Previous discussions regarding the direct product of this reaction are considered (Nature Phys. Sci. 234: 97 and 159 (1971); loc. cit. 237: 46 and 47 (1972)), and it is stated that evidence for the direct production of H atoms is available, based on a fast spectrophotometric method for monitoring the concentration of H atoms in aqueous media following pulse irradiation (see Rev. Sci. Instrum. 40: 786 (1969)). The pertinent observations are summarized, and provide strong evidence that only H atoms, and not H_3O or some other precursor of H atoms with a lifetime of $\sim 10\mu s$, are present in the irradiated solutions. (UK)

7452 STUDIES ON THE ACTION OF γ-IRRADIATION ON STARCH. PART 2. DEVELOPMENT OF CERTAIN BIOCHEMICAL CHARACTERISTICS OF THE STARCH GRANULE AS A FUNCTION OF THE IRRADIATION CONDITIONS. Tollier, M. Th.; Guilbot, A. Staerke; 24: No. 9, 285-90(Sep 1972). (In French).

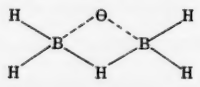
Corn starch and potato starch were γ-irradiated at different hydrations with largely varying irradiation doses. The aspect of the radiochemical degradation of the starch units was explored. Results show that the amount of modified anhydro-glucose units, capable of forming 5-hydroxymethylfurfural upon the action of acid, increases proportionally to the irradiation dose but is independent of the water content of the irradiated sample. The number of COOH groups provides evidence of the important protecting role that the water plays in this kind of alteration. (auth)

7453 PULSE RADIOLYSIS OF 9,10-ANTHRAQUINONES. Pt. 1. RADICALS. Hulme, B. E.; Land, E. J.; Phillips, G. O. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 10, 1992-2002 (1972).

Radicals derived from 1- and 2-substituted 9, 10-anthraquinones were studied using pulse radiolysis. In aqueous solution, both sodium anthraquinone-1- and -2-sulphonates react rapidly with hydrated electrons, and more slowly with formate radicals, to form anthrasemiquinone radical ions ($A\cdot^-$). The absorption spectra and extinction coefficients of both $A\cdot^-$ radical ions were very similar; the corresponding protonated semiquinones ($AH\cdot$) had similar spectral properties also. No significant difference was found in the reactivities of both $A\cdot^-$ radicals towards oxygen, but the pK values for the equilibria $A\cdot^- + H^+ \rightleftharpoons AH\cdot$ differed significantly. OH radicals react rapidly with the 1- and 2-sulphonate to form transient products which have similar spectral properties. Kinetic salt effect studies indicate that such transient products are OH adducts rather than semi-oxidized anthraquinones. The rates of reduction of 1- and 2-piperidinoanthraquinones in alcoholic solution by solvated electrons, or by $\dot{C}H_2O^-$ radicals, to form the corresponding semiquinones, are similar. Reduction by $\dot{C}H_2OH$ in methanol acidified with $10^{-2}M$ H_2SO_4 is much slower for the 1-piperidino derivative than for the 2-derivative, due to differences in the states of protonation of the two quinones. The absorption spectra were found for both unprotonated and protonated forms of these semiquinones, and the corresponding species derived from 1- and 2-aminoanthraquinone. (auth)

7454 E.S.R. SPECTRA OF THE RADICALS PRODUCED IN γ-IRRADIATED DIBORANE IN THE SOLID STATE. Hasegawa, A.; Sohma, J. (Hokkaido Univ., Sapporo). Mol. Phys.; 24: No. 5, 1177-9(Nov 1972).

ESR studies are reported on the intermediate structure of γ-irradiated diborane in the solid state. ESR spectra were obtained after the irradiation at 77°K of polycrystalline samples of the β form of diborane and of deuterated diborane. ESR spectra were also obtained for a single crystal of the β form of diborane. It is concluded from the analysis of the observed ESR spectra that the species of the radical produced by γ-irradiation from diborane could be



and a mechanism for its production is proposed. (UK)

7455 FREE RADICALS IN X-IRRADIATED ^{15}N-LABELLED 5-NITROURACIL. Benson, B. W. (Southern Illinois Univ., Carbondale). Mol. Phys.; 24: No. 5, 1175-6(Nov 1972).

In a single crystal ESR study of γ irradiated 5-nitrouracil (Benson et al., Molec. Phys.; 20: 357(1971)) it was concluded that the unpaired electron of the free radical formed by γ-irradiation was probably localized on N_1 of the pyrimidine ring. It has since been proposed by Symons (Molec. Phys.; 22: 551(1971)) that the unpaired electron is on N_5 of the nitro group. ESR spectra have now been obtained of isotopically labelled 5-nitrouracil, with 96 atom % ^{15}N in the nitro group. Hyperfine coupling and g-factor principal values are presented for irradiated ^{15}N and ^{14}N-labelled 5-nitrouracil. The results are stated to confirm that the free radical has the unpaired electron localized in the nitro group. The experiment does not give any information about the mechanism of formation of the free radicals. (UK)

7456 RADIATION-INDUCED COPOLYMERIZATION OF VINYL ACETATE WITH VINYLIDENE CHLORIDE ON SYNTHETIC FIBERS IN A PRECIPITATING AGENT. Kurilenko, A. I.; Kapustina, I. B. (Belorussian State Univ., Minsk). Vysokomol. Soedin., Ser. A; 14: No. 9, 1982-6(Sep 1972). (In Russian).

The process of preparation of combined fibers by γ-induced synthesis of grafted and nongrafted copolymer of vinyl acetate with vinylidene chloride on polycaproamide and polypropylene fibers in petroleum ether was studied. The dependences of the copolymerization rates on the monomer mixture composition were determined and the copolymerization constants were calculated. (auth)

7457 INVESTIGATION OF THE MECHANISM OF FORMATION OF THE SURFACE GRAFTED LAYER IN RADIATION-INDUCED GRAFT COPOLYMERIZATION. Kabanov, V. Ya.;

Kazimirova, N. M.; Chalykh, A. E. (Inst. of Physical Chemistry, Kiev). Vysokomol. Soedin., Ser. A; 14: No. 9, 2042-7(Sep 1972). (In Russian).

The mechanism of the surface layer formation of copolymers grafted by irradiation was studied by means of optical and electron microscopy as well as profilography for the case of grafting of glycidyl methacrylate onto polyethylene. At the initial stage of copolymerization, regardless of the monomer solvent nature, grafted poly(glycidyl methacrylate) is in the shape of globules, growing and blending as grafting progresses. The effect of the solvent nature manifests itself at the stage of blending of growing globules. At the same percentage of grafting, the amount of surface-grafted copolymer is greater for polar solvents than for nonpolar ones. In the case of grafting from the monomer liquid phase onto oriented samples, the substrate affects both the molecular and the supermolecular structures of the grafted layer. The surface of grafted samples is rough, the roughness increasing in the course of grafting in accordance with the grafted layer thickness. When the degree of grafting reaches 20 to 30% the increase in roughness slows down. The surface roughness of oriented films is less than for nonoriented ones and varies more monotonically in the grafting percentage range studied. (auth)

7458 MODIFICATION OF THE STRUCTURE OF AMORPHOUS ORIENTED POLY(METHYL METHACRYLATE) BY THE METHODS OF GRAFT AND BLOCK COPOLYMERIZATION. Kurilenko, A. I.; Yakimtsov, V. P.; Krul, L. P. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk SSSR; 204: No. 2, 412-15(11 May 1972). (In Russian).

Processes of graft and block copolymerization of polyacrylonitrile (PAN) and polyvinylidene chloride (PVDC) in amorphous films of atactic polymethylmethacrylate (PMMA) which had been oriented by stretching are described. Radiation from a ^{60}Co source was used to induce free radical formation and thus achieve grafting. The pressure of the AN and VDC monomers was chosen so as to maintain a given polymerization rate. Isometric heating of the products, thermogravimetric analyses of samples, behavior toward solvents (dissolution, swelling), and examination in polarized light were used to ascertain structures and properties. (K.S.W.)

7459 CHANGE OF DEGREE OF POLYMERIZATION OF VINYL ALCOHOL COPOLYMERS BY IRRADIATION. Yoshitake, Toshihiko (Kuraray Co. Ltd., Okayama, Japan). Kobunshi Kagaku; 29: No. 325, 310-12(May 1972). (In Japanese).

Change in degree of polymerization of vinyl alcohol (I)–allyl alcohol (II) copolymer and I–isopropenyl alcohol (III) copolymer by the irradiation of ^{60}Co γ-rays in air or vacuum was measured. In both copolymers, degradation of main chain is more predominant than crosslinking. In the case of II copolymer, probability of main chain scission does not depend on the composition of the copolymerized II unit and G value is 1.73. In the case of III copolymer, the main chain scission increases with increasing amount of the copolymerized III unit. A Li near relation is obtained between the composition of III unit and G value of the main chain scission. (auth)

7460 PULSE RADIOLYSIS OF 9,10-ANTHRAQUINONES. Pt. 2. TRIPLET EXCITED STATES. Hulme, B. E.; Land, E. J.; Phillips, G. O. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 10, 2003-12(1972).

The triplet excited states of anthraquinone, 1- and 2-piperidinoanthraquinone and 1- and 2-aminoanthraquinone were studied in benzene using pulse radiolysis. The triplet-triplet absorption spectra and extinction coefficients were characterized via energy-transfer techniques for all but the 1-piperidino derivative. The lowest triplet energy levels of the piperidino- and aminoanthraquinones were similarly located. The lifetime of anthraquinone triplet in benzene is short (τ = 180 ns), and it reacts with oxygen and propan-2-ol with rate constants of 1.5×10^9 and 2.1×10^7 M^{-1} s^{-1}, respectively. No reaction of the triplet with its own ground state could be detected. The triplet states of 2-piperidino-, 1-amino- and 2-aminoanthraquinone are much longer-lived in benzene than anthraquinone. 2-Piperidinoanthraquinone triplet reacts with oxygen with a rate constant of 1.9×10^9 M^{-1} s^{-1}. No reaction of 2-piperidinoanthraquinone triplet with its own ground state or with propan-2-ol could be detected. The different properties of the piperidino- and aminoanthraquinone triplets, in comparison with anthraquinone triplet itself, are considered to arise because their lowest triplet levels are charge-transfer in character, rather than $n\pi^*$. (auth)

7461 EFFECTS OF GAMMA RADIATION ON THE LOW-TEMPERATURE DILUTE-ACID HYDROLYSIS OF CELLULOSE. Kunz, N. D.; Gainer, J. L.; Kelly, J. L. (Univ. of Virginia, Charlottesville). Nucl. Technol.; 16: No. 3, 556-61(Dec 1972).

With the aim of enhancing the conversion of cellulose to glucose by a hydrolysis process, a study was conducted on the effectiveness of irradiating the cellulose prior to subjecting it to hydrolysis. Cellulose, in the form of filter paper, was irradiated with gamma rays and subsequently hydrolyzed in solutions of hydrochloric acid. Combinations from the following conditions: dilute acid (<10% HCl), short hydrolysis times (≤20 h), relatively low temperatures (25 to 90°C) and radiation doses of 2 to 10 Mrad produced cellulose-to-glucose yields of up to 27%. Although these yields are too low to be industrially attractive, the study indicated trends toward cellulose conversion under radiation and hydrolysis conditions that may possibly lie within the range of economic feasibility. (auth)

Radiochemistry and Nuclear Chemistry

Hot-Atom Chemistry

7462 (JUL-873-NC) STEREOCHEMISTRY OF HOT HOMOLYTIC Cl SUBSTITUTION BY RECOIL CHLORINE IN DIASTEREOMERIC HALOALKANES. Machulla, H.-J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Nuklearchemie). Jul 1972. 94p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Cologne Univ., West Ger.

Studied was the Cl-substitution through ^{38}Cl on racemic and meso 2,3-dichlorobutane in solvents with various dielectric constants. Results showed that, depending on both type and amount of solvent, the stereochemical course of the reaction could be influenced within a wide range. Infrared spectrum analysis as well as radiochemical determinations revealed quite different reaction cross sections for the two stereochemical paths of substitution. Proposed was a new model which not only explained the experimental data but also other recent observations about binding energy, electron density, electron negativity, and the formation of highly excited molecules in the hot homolytic substitution. (H.B.G.)

7463 INVESTIGATIONS ON CHEMICAL EFFECTS INDUCED BY NUCLEAR REACTIONS IN ORGANIC MEDIA. Pt. 1. (n,γ) REACTIONS OF IODINE IN HYDROCARBONS. Iyer, R. M.; Mohan, H. (Bhabha Atomic Research Center, Bombay). Radiat. Eff.; 16: No.1-2, 7-15(Sep 1972).

To assess the total radiation damage caused as a consequence of (n,γ) reactions of iodine in hydrocarbons, the extent of added scavenger I_2 consumption per nuclear event has been estimated in the systems $CH_3I + I_2$ + hydrocarbon and I_2 + hydrocarbon, using ^{131}I labelled I_2, gas chromatographic analysis of the product iodides and by spectrophotometry. The results show that a large number (1×10^{10}) of I_2 molecules are consumed for every (n,γ) event on ^{127}I. Neutron irradiation of the frozen matrix at 77°K results in the chemical reaction of 2×10^8 molecules of I_2 for every (n,γ) event. On neutron irradiation of CH_3I alone, I_2 is produced at the rate of 10^{10} molecules per (n,γ) event. The various sources of energy deposition in the system as a result of the nuclear reaction have been assessed and it is suggested that an ionic chain reaction is involved in the chemical fixation of such a large number of iodine molecules. (auth)

7464 INVESTIGATIONS ON CHEMICAL EFFECTS INDUCED BY NUCLEAR REACTIONS IN ORGANIC MEDIA. Pt. 2. $^{127}I(n,2n)^{126}I$ AND $^{130m}I(I.T.)^{130}I$ REACTIONS OF IODINE AND $^{80m}Br(I.T.)^{80}Br$ REACTIONS OF BROMINE IN HYDROCARBONS. Iyer, R. M.; Mohan, H. (Bhabha Atomic Research Center, Bombay). Radiat. Eff.; 16: No. 1-2, 17-24(Sep 1972).

Results are reported of nuclear reactions of iodine [$^{127}I(n,2n)^{126}I$ and $^{130m}I(I.T.)^{130}I$] and bromine [$^{80m}Br(I.T.)^{80}Br$] in cyclohexane, hexane, and heptane. From the extent of scavenger I_2 (labelled with ^{131}I) and Br_2 (labelled with ^{82}Br) consumed as a result of the nuclear transformations, as monitored by the ^{131}I and ^{82}Br activity in the organic form, the number of scavenger molecules taking part in chemical reactions for every (I.T.) or (n,2n) reaction were determined. The values for the iodine and bromine nuclear reactions are 5×10^8 and 2×10^8 molecules respectively. Reaction products like iodocyclohexane, monobromo- and dibromocyclohexane were identified by gas chromatography. The importance of these results in understanding chemical effects of nuclear transformation is stressed. (auth)

7465 CHEMICAL EFFECTS OF NUCLEAR REACTIONS DUE TO THERMAL NEUTRONS. PART II. RECOMBINATION REACTIONS. Mahieu, B.; Apers, D. J.; Capron, P. C. (Univ., Louvain, Belg.). Rev. Quest. Sci.; 143: No. 3, 335-47(1972). (In French).

The immediate condition of the atom that has captured a neutron and which because of this has recoiled across the surrounding matter is discussed. The theoretical information obtained does not permit a precise determination of the nature of the recoil fragment but tends, nevertheless, to prove that it is present in an

oxidation state near zero and that it is stripped of all its ligands. After dissipation of the excess kinetic energy, the bonds can be formed again to stabilize the atom in the form of a new compound. An appropriate treatment, especially an increase in temperature, facilitates the formation of new bonds and thus restores the recoil atom to an environment similar to that which it had at the start. It should be remembered that we are considering only the case of crystalline solids. (tr-auth)

7466 RECOIL LABELLING OF SULFOBROMOPHTHALEIN WITH ^{82}Br DURING NEUTRON IRRADIATION. Schuhmacher, J.; Maier-Borst, W. (German Centre for Cancer Research, Heidelberg). Int. J. Appl. Radiat. Isotop.; 23: No. 11, 519-25(Nov 1972).

A column chromatographic purification procedure to separate recoil ^{82}Br-labeled-sulfobromophthalein (^{82}Br-BSP) from all other irradiation products is described. Radiochemical purity of isolated ^{82}Br-BSP is determined by chemical and physico chemical methods as well as by in vivo experiments. Retention of ^{82}Br on BSP is calculated. (auth)

Properties of Radioactive Materials

Refer also to abstracts 7362, 7397, 7398, and 7416.

7467 (LCA/MS-RAE-3-645) PREPARATION OF AN ^{131}I LABELED FERRIC OXIDE AEROSOL. Larcher, J. (Laboratoire Central de L'Armement, Arcueil (France)). Jul 1972. 17p. (In French). Dep. NTIS (U. S. Sales Only).

An ^{131}I-labeled Fe_2O_3 aerosol was prepared by coprecipitating ferric hydroxide and silver iodide in view of studying the effects on animals of inhaling radioactive aerosols. The labeled product and the aerosol were subjected to certain quality control procedures: yield and labeling efficiency, nature of the labeling (studied by the sedimentation technique), and granulometry. Measurements of the solubility of the compound in human pools were effected; the solubility was found to be 0.16 g l^{-1}, the known quantities of ^{131}I-labeled ferric oxide being continually agitated in known volumes of serum. (France)

7468 CRYSTALLINE STRUCTURE OF $Cs_4[(UO_2)_2F_8].2H_2O$. Mukhailov, Yu. N.; Udovenko, A. A.; Kuznetsov, V. G.; Shchelokov, R. N. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Strukt. Khim.; 13: No. 4, 743(1972). (In Russian).

Monoclinic crystals of $Cs_4[(UO_2)_2F_8] \cdot 2H_2O$ have the following parameters: a = 8.077, b = 12.201, c = 9.277, β = 108° 55′, and N = 2. The structural units are the dimeric complex anion $[(UO_2)_2F_8]^{4-}$, cesium cations, and water molecules. The dimeric anion has the form of two pentagonal bipyramids. The O–U–O angle is nearly linear (177.3°), the two U–O distances being 1.74 and 1.88 Å. (K.S.W.)

7469 CRYSTALLINE STRUCTURE OF $K_5(UO_2)_2F_9$. Mukhailov, Yu. N.; Udovenko, A. A.; Kuznetsov, V. G.; Davidovich, R. L. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Strukt. Khim.; 13: No. 4, 741(1972). (In Russian).

Single crystals of $K_5(UO_2)_2F_9$ have a lamellar habit. The structure is monoclinic: a = 19.75, b = 11.584, c = 6.096 Å, γ = 101° 19′, N = 4. The structural unit is the dimeric complex anion $[(UO_2)_2F_9]^{5-}$ and potassium cations, the anion being two pentagonal bipyramids. The O–U–O angle is nearly linear (177.5°), and the U–O distance = 1.93 and 1.95 Å. One F atom functions as a bridge between the two U atoms, this U–F distance = 2.42 Å. (K.S.W.)

7470 COMPLEX COMPOUNDS OF TETRAVALENT URANIUM WITH HETEROCYCLIC COMPOUNDS. Rakhimov, Kh. R.; Muftakhov, A. G.; Khamraev, T. A. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 2, 35-6(1971). (In Russian).

Complex formation of uranium(IV) sulfate with pyridine, α-picoline, pyridine N-oxide, and quinoline N-oxide was studied in aqueous solutions at a pH of 4.2 and an ionic strength of 0.25. The resulting complexes were examined spectrophotometrically in the visible region, and their instability constants and molar electroconductivities were measured. (K.S.W.)

7471 INVESTIGATIONS OF INCREASE OF THE EFFICIENCY OF AN AFTERBURNING CATALYST. Schwab, G. M. (Univ., Munich); Donga, G. Chem.-Ing.-Tech.; 44: No. 16, 957-62(1972). (In German).

Starting from an alkaline copper oxide/manganese oxide catalyst on a silicilic acid carrier, an investigation was made of the influence of n and p dosage on the activity of post combustion catalysts for cleaning motor exhausts. By using a measuring procedure for registering the time dependence of the reaction adjustment, an exact collation could be made between the gas produced and the catalyst temperature also in exothermic reactions. The catalyst activity was decreased by the p-dosage with alkali due to the concentration of n-dosage with quadrivalent ions. Above all thorium proved to be a most effective promoter. Besides the temperature dependence of the gas production, one could also determine the reaction kinetics parameter. The results agree with the estimations on the relationship between semi-conductor and catalyst properties of metal oxides. (GF)

7472 CRYSTAL STRUCTURE OF TETRA-AMMONIUM URANYL TRICARBONATE. Graziani, R.; Bombieri, G.; Forsellini, E. (Univ., Venice). J. Chem. Soc., Dalton Trans.; No. 19, 2059-61(1972).

Crystals of tetraammonium uranyl tricarbonate are monoclinic, a = 10.68, b = 9.38, c = 12.85, β = 96°27′, Z = 4, space group C2/c. The structure was solved by Patterson and electronic-density syntheses by use of three-dimensional counter data, and refined by least-squares to R 0.076 for 1833 reflections. The uranium (VI) atom is in an eight coordinate distorted hexagonal environment. The linear uranyl group is perpendicular to the equatorial plane in which three carbonate groups are chelated. The NH_4^+ groups which fill holes in the structure link the anions through hydrogen bonding. (auth)

7473 COORDINATION OF THE URANYL ION. Masaguer, J.; Rodriguez, C.; Munoz, M. (Univ. Santiago de Compostela, Santiago, Spain). Acta Cient. Compostelana; 7: No. 3-4, 129-34 (1970). (In Spanish).

The formation of uranyl complexes with nitro, selenocyanate, and thiocyanate ligands was studied by spectrophotometric methods. Suitable solvents are MeCN and DMF. Optical extinction coefficients between 300 and 600 nm were measured with a Beckman DU spectrophotometer and SiO_2 cells with 1.0-cm optical path. (Selenium-Tellurium Abstr.)

7474 SPECTRAL AND MAGNETIC STUDY OF THE COMPLEX FORMED BETWEEN URANYL AND 8-AMINO-7-HYDROXY-4-METHYLCOUMARIN. Rastogi, D. K.; Srivastava, A. K.; Jain, P. C.; Agrawal, B. R. Analusis; 1: No. 3, 228-30(Jul 1972). (In French).

The uranyl ion was observed to form a lemon-orange color complex with 8-amino-7-hydroxy-4-methylcoumarin at a pH lying between 2.5 and 5.2. Spectrophotometric measurements gave a composition of 1 : 2 (metal : ligand). The formation constant was determined at a pH of 4.5 and found to be equal to 8.56. The corresponding formation free energy is –11.73 Kcal at 27°C. A brown complex, $UO_2(C_{10}N_8NO_3)_2H_2O$ was also isolated. Measurements were effected in order to determine the electrolytic characteristics, magnetic susceptibility, and the ultraviolet, visible and infrared spectra of the complex. Its structure was defined. (France)

7475 HYDROLYSIS OF IONS OF RARE EARTH ELEMENTS, YTTRIUM, SCANDIUM, AND THORIUM IN WATER AND WATER–ETHANOL MIXTURES. Usherenko, L. N.; Skorik, N. A. (Tomsk State Univ., USSR). Zh. Neorg. Khim.; 17: No. 11, 2918-2921 (Nov 1972). (In Russian).

The hydrolysis constants were determined for the ions La, Eu, Gd, Y, Yb, Lu, Sc, and Th in water and water–ethanol mixtures containing 19.8 and 40.3% ethanol at an ionic strength of 0.05 and a temperature of 25°C. The logarithms of the stability constants of the hydroxy complexes of these ions possessed a linear relationship to the reciprocal of the permittivity of the solvents. (tr-auth)

7476 OXIDATION–REDUCTION PROCESSES IN THE SYSTEM U_3O_8–$MoCl_5$. Eliseev, S. S.; Glukhov, I. A.; Bozhdaeva, E. E.; Malysheva, L. E. (Inst. of Chemistry, Dushanbe, USSR). Zh. Neorg. Khim.; 17: No. 11, 3022-5(Nov 1972). (In Russian).

U_3O_8 undergoes a reaction with $MoCl_5$ in the neighborhood of 180°C according to the equation: $U_3O_8 + 4MoCl_5 \rightarrow 3UCl_4 + 4MoO_2Cl_2$. This reaction, and a subsidiary reaction: $3MoOCl_3 + 3UOCl_3 \rightarrow 3UCl_4 + 3MoO_2Cl_2$ were studied by thermographic analysis to determine the temperatures of the maximum exo-effects for the reactions given. To achieve the former reaction, the starting materials U_3O_8 and $MoCl_5$ must be used in stoichiometric proportions, since an excess of U_3O_8 leads to oxychlorides of U, and an excess of $MoCl_5$ leads to disproportionated $MoOCl_3$. (K.S.W.)

7477 IMPROVEMENTS IN OR RELATING TO RADIOACTIVE MATERIALS. Turner, J. C.; Sheppard, G. (to United Kingdom Atomic Energy Authority). British Patent 1,288,220. 6 Sep 1972. Filed 13 Jan 1969.

A method is described for the preparation of a ^{14}C labeled inulin derivative for use in investigating kidney function. The inulin derivative has a hydroxymethyl group with a ^{14}C atom, and is prepared in a physiologically inert saline solution of concentration 1.6 to 5 mg/ml. Inulin is methylated to form a methyl ester and then reduced to alcohol. The methylating agent is diazomethane and the reduction is effected with sodium borohydride. (UK)

7478 STRUCTURE OF THE BINUCLEAR $(UO_2)_2F_9^{5-}$ ION IN $K_5(UO_2)_2F_9$. Nguyen Quy Dao; Chourou, S. (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France). Compt. Rend., Ser. C; 275: No. 14, 745-8(2 Oct 1972). (In French).

The $(UO_2)_2F_9^{5-}$ ion observed in the structure of $K_5(UO_2)_2F_9$ consists of two pentagonal bipyramids with a common apex. The angle formed between the two base planes is 120°. Each $(UO_2)_2F_9^{5-}$ ion is surrounded by 20 potassium atoms forming a hexagonal prism bound by two trigonal pyramids. The interatomic distances were determined. The structure of the $K_5(UO_2)_2F_9$ complex was studied using x-ray diffraction techniques with a single crystal. The diffracted intensities were recorded with a Weissenberg chamber. The Patterson method was used to investigate the positions of the U atoms. (France)

7479 PHOTOCHEMICAL REDUCTION OF URANYL NITRATE WITH ETHANOL. Kireeva, G. N.; Savel'eva, V. I.; Sokolova, I. D.; Gromov, B. V. (Inst. of Chemical Engineering, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 4, 531-3(Apr 1972).

Translated from Zh. Fiz. Khim.; 46: No. 4, 919-22(Apr 1972).

The photochemical reduction of uranyl nitrate by ethanol was investigated. The uranium nitrate solutions formed on photochemical reduction are unstable and rapidly oxidize on standing. The reduced uranium can be stabilized by introducing fluoride ions and reducing solutions. Quadrivalent uranium then forms complexes with mixed ligands having the composition $UF(NO_3)_3 \cdot nH_2O$ and $UF_2(NO_3)_2 \cdot nH_2O$, which are very soluble and chemically stable. The effect of the initial concentrations of uranyl nitrate and ethanol on the reduction process was demonstrated. The quantum yield of the reaction on irradiation of the solutions with monochromatic and polychromatic light was measured and its temperature variation was found. (auth)

7480 PREPARATION OF URANIUM OXIDE TETRAFLUORIDE. Wilson, P. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Chem. Soc., Chem. Commun.; No. 22, 1241(22 Nov 1972).

The new compound, UOF_4, has been prepared by the reaction of UF_6 with H_2O in a HF slurry. (auth)

7481 TRANSMISSION OF EXCITATION ENERGY BETWEEN THE URANYL ION AND IONS OF U(IV) AND RARE EARTHS IN SOLUTIONS. Skutov, I. K.; Umreiko, D. S. (Belorussian State Univ., Minsk). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 5, 976-8 (May 1972). (In Russian).

The transfer of electron energy of excitation of uranyl compounds to U(IV) centers and to rare earth ions in solutions was experimentally measured at 77°K. This phenomenon was strongly dependent on the nature of the solvent (water, inorganic acids, alcohols). (tr-auth)

7482 COMPARISON OF EXPERMENTALLY AND THEORETICALLY DETERMINED VALUES FOR THE BOILING POINT OF ALKYLASTATINE COMPOUNDS. Hoffman, P. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta; 17: No. 3, 169-70(Oct 1972). (In German).

The boiling points of alkylastatine compounds were extrapolated from molecular weight data. These values agreed with measured values for methylastatine. (M.C.G.)

7483 OXIDE FLUORIDES $A^{I}_{12}M^{IV}M_3^{VI}O_8F_{18}$. Fleckenstein, J.; Kemmler, Sack, S.; Ruedorff, W. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 27b: No. 10, 1272-3(Oct 1972). (In German).

In the systems alkali–uranium–oxygen–fluorine, cubic crystallized oxide fluorides are formed which contain 4- and 6-valent uranium in the ratio 1:3. The alkali can be Rb, Cs, K, and Tl. Reaction of the basic chemicals was achieved under argon in slightly sealed platinum tubes. For the potassium compound, a five-hour heating at 700°C was required. The reaction yielded a greenish-beige sinter body. Lattice constants and analytical data for the various compounds are tabulated. The compounds can be produced not only with 4- and 6-valent uranium but also with other cations. Substitution of uranium(IV) by Zr, Ce, or Th yields deep red, slightly hygroscopic sinter bodies. (H.B.G.)

7484 BASIC SALTS OF URANYL FLUORIDE. Seleznev, V. P.; Tsvetkov, A. A.; Sudarikov, B. N.; Gromov, B. V.; Khozhainov, Yu. M. (Moscow Chemico-Technological Inst.). Zh. Neorg. Khim.; 17: No. 11, 3126-7(Nov 1972). (In Russian).

A number of variable compounds were synthesized and characterized by x ray diffraction: $UO_2(OH)_xF_{2-x} \cdot 2H_2O$ and $UO_2(OH)_xF_{2-x} \cdot H_2O$, where x = 0.3 to 1.2. Pycnometric densities of the samples suggest the composition $UO_2(OH)_{0.3}F_{1.7} \cdot 2H_2O$ for a density of 4.66 g/cm³, and $UO_2(OH)_{1.1}F_{0.9} \cdot H_2O$ for a density of 4.82 g/cm³. X ray diffraction for the two types of compounds x = 0.3 to 1.2 were closely similar. (tr-auth)

7485 SCHIFF BASE COMPLEXES OF OXOCATIONS. 1. URANYL COMPLEXES WITH TETRADENTATE OPTICALLY ACTIVE SCHIFF BASES OF SALICYLALDEHYDE. Pasini, A.; Gullotti, M.; Cesarotti, E. (Univ., Milan). J. Inorg. Nucl. Chem.; 34: No. 12, 3821-33(Dec 1972).

The synthesis and properties of uranyl complexes with tetradentate ligands of formula UO_2 (saldiamine) · L (where saldiamine is the Schiff base N,N′-diaminebis(salicylideneimine), and the diamines are ethylenediamine, (+) propylenediamine, (+) and meso butanediamine, (+) and meso cyclohexanediamine, (–) and meso stilbenediamine and L is a solvent molecule) are reported. IR, electronic and circular dichroism spectra are also discussed. (auth)

7486 REDUCTION OF TOXICITY DUE TO HYDROGEN TRITIUM OXIDE. Holmes, R. E.; Clarke, D. A. (to Atomic Power Constructions Ltd.). British Patent 1,289,309. 13 Sep 1972. Filed 31 Dec 1968.

A method is described for treatment of liquid containing HTO to reduce its toxicity, such as in the water removed from a reactor coolant system by a drying stage. The HTO is converted into HT by an electrolysis process. The liberated gas may be used in the production of CH_4 gas for incorporation in the coolant, and the oxygen may be used in producing CO_2 for the coolant. The liquid undergoing electrolysis is neutralized, distilled, and subjected to the action of an alkali to increase its conductivity, and any oily product removed before electrolysis. Cooling systems provided with the necessary equipment for these processes are described. (UK)

Radioactive Waste Treatment

7487 (ETR–274) BITUMINIZATION OF RADIOACTIVE WASTES. Bibliography. Drent, W.; Eschrich, H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Jun 1972. 64p. NTIS (U. S. Sales Only).

This bibliography gives a hundred references to papers on investigations related to the solidification of radioactive wastes by incorporation into bitumen. Abstracts of most of the papers are included. An attempt was made to list all publications on the subject considered that have appeared in the period 1958 to the beginning of 1972. (auth)

7488 (SRARI-P–134) EFFECT OF SKTN-1 ON THE SUPPRESSION OF FOAM DURING EVAPORATION OF RADIOACTIVE SOLUTIONS. Bagretsov, V. F.; Arzhannikov, Yu. S. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1972. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

Data on synthetic rubber CKTH-I application as a foam-quencher when processing liquid radioactive wastes at an industrial evaporation plant are given. The rubber suppresses the foam completely. Its operation time is 3 to 6 hours and the flow rate is 10 to 17 g per 1 m³ of solution with concentrations of 50 to 150 g/l. Using CKTH-I promotes more stable evaporator operation and permits higher quality condensate to be obtained with lower contents of radioactive elements and salts. (auth)

7489 RADIOACTIVE WASTE TREATMENT AT THE FUKUSHIMA NUCLEAR POWER STATION. Nomura, A. (Tokyo Electric Power Co. Inc.). Genshiryoku Kogyo; 18: No. 3, 43-7(Mar 1972). (In Japanese).

The system of radioactive waste treatment in the Fukushima Station is described. Waste gas from a turbinecondenser, in which hydrogen and oxygen gases from radiolysis are converted to water by a recombiner and removed, is compressed and stored in a tank for 24 hr to reduce radioactivity. Then it is filtered and released in the air. The other waste gas is composed mostly of air and is released in the air after a storage of 2 min. Liquid wastes are as follows: leakage of water from pumps or valves called machine drain, wastes by the regeneration of ion exchange resin called chemical waste, and other waste water. The machine drain is filtered, desalted, and used again. The chemical waste is concentrated and treated as solid waste. The other liquid wastes are filtered, diluted, and abandoned. Solid wastes are as follows: filter sludge, spent ion exchange resin, the concentrated chemical wastes, spent parts of equipments, and other solid wastes. The wastes with high activity are stored in a tank for several years to reduce the activity, poured in steel drums with cement, and solidified. These drums are stored in a special place. Various efforts are made to reduce the number of the drums. (Japan)

7490 RADIOACTIVE WASTES. Vesely, V. Prague; Academia (1971). 154p. (In Czech).

The problems of deactivation and disposal of radioactive wastes from nuclear installations are dealt with, and a brief outline of possible solutions is given. Topics discussed include: the sources,

the amounts, and the composition of radioactive wastes; water conservation and hygiene problems presented by radioactive waste waters; deactivation stations, specialized research institutes, and nuclear power plants; the disposal of wastes from spent fuel reprocessing; the treatment and the disposal of solid wastes; and the separation of gaseous effluents. (INIS)

Radioisotope Production

7491 (ORNL-tr-2649) CHEMICAL PURIFICATION OF ELECTROMAGNETICALLY SEPARATED ISOTOPES OF CALCIUM AND MAGNESIUM. Kellner, K. Translated by L. T. Newman and P. S. Baker (Oak Ridge National Lab., Tenn.), from Isotopenpraxis; 8: No. 2, 61-4(1972). 9p. Dep. NTIS.

The collected isotopes separated in an electromagnetic isotope separator are contaminated by a great number of foreign elements. Before the isotopic products can be used for scientific investigations, it is necessary to separate them from all accompanying elements and to convert them to a stable form. The chemical purification technology for electromagnetically separated isotopes of magnesium and calcium is described. Finally the sample chemistry for the mass spectrometer analysis of both elements is discussed. (auth)

7492 (UCRL-Trans-10652) INORGANIC ION EXCHANGER. Tachimori, S.; Amano, Hiroshi. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from report JAERI-13726. 108p. Dep. NTIS.

Information is summarized on the inorganic ion exchangers that have been found in the literature in order to apply them to the field of radioisotope production. Individual reports are mainly collected from "Journal of Inorganic and Nuclear Chemistry," and "Inorganic Ion exchangers" by C. B. Amphlett is used as a reference book with a view to systematize the collected information. (auth)

7493 SEPARATION AND PURIFICATION OF CARRIER-FREE COPPER ISOTOPES FOR MEDICAL USE. Brown, L. C.; Callahan, A. P. (Oak Ridge National Lab., TN). Int. J. Appl. Radiat. Isotop.; 23: No. 11, 535-8(Nov 1972).

The double ion exchange separation described by O'Brien [Int. J. Appl. Radiat. Isotopes; 20: 121 (1969)] was found unacceptable for routine processing of larger ZnO production targets rapidly and economically. As a result, an improved separation and purification scheme, suitable for the preparation of either the shorter-lived ^{64}Cu or ^{67}Cu in carrier-free form and suitable for human use, was developed and tested. This new chemical separation scheme is based on the data of Poskanzer and Foreman [J. Inorg. Nucl. Chem.; 16: 323 (1961)] and Scruggs et al. [J. Phys. Chem.; 67: 2194 (1963)] and utilizes the solvent extraction of carrier-free Cu(II) from dilute HCl into thenolytrifluoroacetone (TTA) in benzene. Total high level radiation cell processing times of <3 hr, chemical yields of >90 per cent, and product purities of >99.5 per cent (exclusive of other copper isotopes) are all typical for this procedure. (auth)

7494 POLYCHENIE RADIOAKTIVIKH IZOTOPOV. (Production of Radioactive Isotopes). Levin, V. I. Moscow; Atomizdat (1972). 256p.

The methods of producing radioisotopes by irradiating selected targets and processing the mixture of materials obtained are described in detail for all applicable isotopes from tritium to "element 105." Decay schemes, half-lives, and similar data are included for each isotope. The nuclear reactions and chemical separation techniques involved are summarized. 491 references. (K.S.W.)

7495 DEVELOPMENT OF FISSION GAS PRODUCTION REACTOR LOOP. McLain, M. E. Jr. (Georgia Inst. of Tech., Atlanta). Nucl. Technol.; 16: No. 3, 568-9(Dec 1972).

A method for the production of fission gas isotopes was developed, which is particularly suitable for research reactors lacking extensive hot cell and high-level liquid waste handling facilities. The method centers about the development of very high surface area ^{235}U target material. Insertion of this target material into the reactor neutron flux permits removal of gaseous fission products from the target for further processing and utilization outside the reactor. (auth)

7496 ON-LINE RADIOCHEMICAL ANALYSIS FOR CONTROLLING RAPID ION EXCHANGE RECOVERY OF TRANSPLUTONIUM ELEMENTS. Wakat, M. A.; Peterson, S. F. (Savannah River Lab., Aiken, SC). Nucl. Technol.; 17: No. 1, 49-57(Jan 1973).

An on-line radiochemical monitoring system was developed to provide control information for the pressurized cation exchange chromatography process used at Savannah River to recover kilogram quantities of transplutonium elements. The effluent from the ion exchange column is circulated past NaI, BF_3, and Ge(Li) detectors located outside the primary shielding wall. The individual radioisotopes are qualitatively and quantitatively analyzed. The system uses a PDP-9 computer with direct memory access for the pulse height analysis of incoming data. (auth)

Reactor Fuel Reprocessing

7497 (ANL-7946) CHEMICAL ENGINEERING DIVISION FUEL CYCLE TECHNOLOGY QUARTERLY REPORT, APRIL-JUNE 1972. Webster, D. S.; Jonke, A. A.; Bernstein, G. J.; Levitz, N. M.; Miller, W. E.; Steindler, M. J.; Vogel, R. C. (Argonne National Lab., Ill.). Sep 1972. Contract W-31-109-eng-38. 63p. Dep. NTIS.

Work was done in the following areas: (1) study of criticality and entrainment problems in the conceptual design of a distillation unit for the recovery of U-Pu from Zn-Mg solutions, investigation of the kinetics of the reaction between Ca_3N_2 solid particles and Zn-Mg-U solution, and study of the separation of CaO from $CaCl_2$ by an equilibrium phase separation; (2) engineering-scale work on the denitration of uranyl nitrate-plutonium nitrate feed solutions to UO_3-PuO_2 powder in a fluid bed, the dissolution of UO_3-PuO_2 denitration product for recycle to the denitrator, and the evaluation of a jet grinder; (3) study of the effects of particle size and particle-size distribution on the precision of x-ray fluorescence analysis in determining Pu/U ratios in LMFBR oxide fuel; (4) measurement of the extraction efficiency of the ANL long-rotor centrifugal contactor (for application to solvent extraction of LMFBR fuels); and (5) operation of an electrolytic cell (for the reduction of plutonium for a Purex process application) with a new titanium-screen cathode to measure reduction rates and current efficiencies with this experimental setup. (auth)

7498 (DOCKET-50201-134) WEST VALLEY REPROCESSING PLANT. Request for Exemptions from 10 CFR 20.408. (Nuclear Fuel Services, Inc., Rockville, Md.). 13 Nov 1972. 2p. Dep. NTIS.

An exemption from 10 CFR 20.408 and approval of an alternative thereto are requested. The regulation deals with radiation exposure records for individuals assigned to work in the facility. The use of contractors that use employees who work on an irregular basis for indeterminate periods of time is given as the reason for the request. (M.C.G.)

7499 (DOCKET-50268-37) MIDWEST FUEL RECOVERY PLANT. Amendment 32, Planned Process Changes. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 16 Oct 1972. 17p. (NEDO-10178-14). Dep. NTIS.

Information is presented in support of the application for an operating license. Process changes that will improve the process operation efficiency, safety margins, and waste management of the plant are described. Routing for high-level recovered acid to the leacher, saw and shear fines disposal system, routing of low-level recovered acid to the HCU concentrator tower, provision of an additional routing for HCU rework, rerouting of the organic vent subheader to the process vent system, and provision of jet grinders in the uranyl nitrate hydrate calciner are discussed. (M.C.G.)

7500 (DOCKET-50268-38) MIDWEST FUEL RECOVERY PLANT. Safety Evaluation. (Directorate of Licensing (AEC), Washington, D. C.). Nov 1972. 114p. Dep. NTIS.

Results of the staffs' evaluation of the health and safety aspects of the plant related to the Commission's licensing requirements are summarized. A technical review was made of information submitted on: population density and land use characteristics of the site environs, physical characteristics of the site, design of equipment and systems from standpoint of nuclear criticality and uncontrolled chemical reaction prevention, equipment and systems used to process and store waste fission products, ventilation and off-gas systems, product loadout systems, receipt of fuel with respect to capability for handling abnormal as well as normal shipping casks, safety related structures in relation to the most severe impact of natural phenomena, the applicants' technical competence and organization, the quality assurance program, and the financial resources of the applicant. The ACRS report is attached as Appendix I. (M.C.G.)

7501 (DOCKET-50268-39) MIDWEST FUEL RECOVERY PLANT. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 184p. Dep. NTIS.

The plant will recover U, Pu, and Np from irradiated fuels by a combination of solvent extraction, ion exchange, and fluoride vola-

tility techniques. There will be no release of radioactive materials in liquid plant effluent. Gaseous radioactive material will be released, but will not cause a discernible environmental effect. The plant's maximum annual contribution to the whole body dose commitment of neighboring residents is limited to 1.08 millirem (less than 1% of that due to natural background). It was concluded that an operating license should be issued, subject to the following conditions for protection of the environment: positive measures to preclude degrading groundwater with wastes from the water demineralizer, installation of equipment for capture and retention of HF entrained in waste hydrogen effluent, prevention of escape of HF gas, and an adequate environmental monitoring program. (M.C.G.)

7502 (DOCKET-50332-27) BARNWELL NUCLEAR FUEL PLANT. Environmental Report, Revision of November 20, 1972. (Allied-Gulf Nuclear Services, Barnwell, S. C.). 20 Nov 1972. 637p. Dep. NTIS.

Reflected in this revision is the detailed design of the separations facility, description of the monitoring of fluoride impact on the environment, update of the impact of liquid discharges on Lower Three Runs Creek, and description of the impact on the groundwater table of Barnwell Nuclear Fuel Plants' pumpage from the Tuscaloosa aquifer. (auth)

7503 (ICP-1009) SAFETY ANALYSIS REPORT FOR THE ICPP ELECTROLYTIC DISSOLUTION PROCESS. Offutt, G. F. (ed.) (Allied Chemical Corp., Idaho Falls, Idaho. Idaho Chemical Programs Operations Office). Oct 1972. Contract AT(10-1)-1375. 89p. Dep. NTIS.

The process description of the electrolytic dissolution system at the Idaho Chemical Processing Plant is presented. Major equipment and instrumentation are described. Hazards evaluations for criticality, radioactive nuclide emission, and off-gas handling demonstrate that the process will be operated safely with regard to the public, operating personnel and equipment. (auth)

7504 (SRARI-P-149) SMALL SIZE CENTRIFUGAL EXTRACTOR SCE-30. Kuznetsov, G. I.; Zelenin, P. I.; Cheryvakov, V. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The small-size centrifugal extractor SCE-30 with flowrates up to 12 l/h was developed and tested. The system of 2M HNO_3 – 1,1 tributyl phosphate in synthine mixture of hydrocarbons formed by catalytic reduction of carbon monoxide by hydrogen; a synthetic approximation of petroleum was used. The mechanical phase entrainment does not exceed 0.02% at flowrates up to 19 l/h. The extractor efficiency is higher than 90% at flowrates up to 12 l/h. (auth)

7505 PROCESS FOR REPROCESSING OF OXIDE NUCLEAR FUELS. Wurm, J. G. (to Commission of the European Communities). German Patent 1,467,322. 22 Jun 1972. (In German).

In the process for reprocessing oxide nuclear fuels, UO_2 in basic fused alkali compounds in the presence of oxidants is converted to alkali uranate. The fission gases given off as well as the parts of the fuel element coverings are extracted from the melt. Finally the precipitated alkali uranate is separated in powder form from the liquid melt. The filtrate containing soluble fission products such as molybdenum or niobium in solution form is treated with Al_2O_3, SiO_2, or other oxides in order to bring about the formation of a solid, water-insoluble, cement-like mass. (GF)

7506 PROCESS FOR SEPARATING Np FROM Pu. Bathellier, A.; Gourisse, D. (to Commissariat a l'Energie Atomique). French Patent 2,111,990. 16 Jun 1972. Filed 3 Oct 1969. (In French).

The separation of Np from Pu was studied in view of recovering ^{237}Np from effluents produced in plants concerned with the processing of irradiated nuclear fuels or the purification of the ^{238}Pu produced by irradiating ^{237}Np. When Np is to be used for α sources, it is necessary that it is separated from ^{238}Pu. Organic solvents (such as trilaurylamine) were used to extract Np(IV) nitrate complexes, the solvent being mixed with an aqueous feed solution containing the elements to be separated and a reducing agent (a ferrous salt). The solvent is washed by an aqueous reducing sulfonitric solution; the addition of sulfate ions causes the complexing of the Pu and its partial transferrence into an aqueous phase in which it is reduced. The washing and/or feed solution contains hydrazine to avoid the oxidation of the Fe(II) and the Pu(III). (France)

7507 SEPARATION OF MOLYBDENUM FROM ^{238}Pu DIOXIDE. Zanotelli, W. A.; Silver, G. L.; Bowling, W. C.; Wells, S. B. (Mound Lab., Miamisburg, OH). Nucl. Technol.; 17: No. 1, 82-4 (Jan 1973).

Two methods by which molybdenum metal coatings may be removed from plutonium dioxide shards are: (1) fusion of the coated shards in a mixture of potassium nitrate and potassium hydroxide, cooling the melt, and washing the unattacked shards with water; or boiling the shards in an aqueous solution of sodium hypochlorite containing a small amount of mercuric nitrate as a catalyst and washing the unattacked shards with water. Both methods remove sufficient molybdenum from the shards (or pellets of compacted shards weighing not more than one half gram each) so that the remaining molybdenum does not pose any problems in subsequent nitric acid based recovery operations. The fusion technique generates a smaller volume of liquid waste and does not introduce chlorine into steel recovery facilities. (auth)

ENGINEERING

Energy Conversion

Refer also to abstract 7520.

7508 (AED-C-12-26) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. Section 12: Nuclear Science Literature of Eastern Countries. Number 26: MHD Generators. Mardak, N.; Vaupel, G. (comps.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Leopoldshafen (West Germany)). Sep 1972. 22p. (In German and English). Dep. NTIS (U. S. Sales Only).

One hundred sixty-nine references are included along with an alphabetized author index. (J.R.D.)

7509 (NP-19606) SOME ASPECTS OF THE ENVIRONMENT AND ELECTRIC POWER GENERATION. Denis, Sylvain (Rand Corp., Santa Monica, Calif.). Feb 1972. 32p.

Energy use in the form of electricity represented 9.3 percent of all energy used in the United States in 1969, but required 20 percent of all fossil fuels consumed. To these fossil fuels must be added hydropower and nuclear power. Electricity's share of all energy is expected by some people to reach 40 percent by the year 2000. This would mean that the problems to be met by electric utilities, the government, and the public will probably be at least four times bigger than at present. The available information on the relationship between electric power generation and the environment is reviewed. The focus is primarily on cost estimates for devices intended to control pollution. The relative importance of the various problems and of the costs required to overcome them are considered, with emphasis on the impact of the costs of pollution control on the prices of electricity for consumers in the various sectors and on the rate of increase in the demand for electric power. The possible influence of the environmental constraints on the pattern of consumption of fossil fuels by electric utilities is also considered. (C.H.)

7510 METHODS FOR UTILIZING MAXIMUM POWER FROM A SOLAR ARRAY. Decker, D. K. JPL Quart. Tech. Rev.; 2: No. 1, 37-48(Apr 1972).

Ion thrusters are being considered for outer-planet spacecraft propulsion for future missions. In a typical mission, the spacecraft primary energy source may be required to deliver as high as 16 kW of power to the thruster system. This power level is quite high compared to system power levels developed in the past. It is therefore very important to utilize the maximum available power from the energy source at all times. A preliminary study of maximum power utilization methods was performed for an outer-planet spacecraft using an ion thruster propulsion system and a solar array as the primary energy source. The problems which arise from operating the array at or near the maximum power point of its I-V characteristic are discussed. Two closed-loop system configurations which use extremum regulators to track the array maximum power point are presented. Also, three open-loop systems are presented that either measure the maximum power of each array section and compute the total array power, utilize a reference array to predict the characteristics of the solar array, or utilize impedance measurements to predict the maximum power utilization. The advantages and disadvantages of each system are discussed and recommendations for further development are made. (auth)

7511 END EFFECTS IN FARADAY TYPE MHD GENERATORS WITH NONEQUILIBRIUM PLASMAS. Houben, J. W. M. A.; Blom, J. H.; Rietjens, L. H. Th. (Eindhoven Univ. of Tech., Netherlands). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 11, 1513-16(Nov 1972).

The influence of the end losses on a linear nonequilibrium Faraday-type MHD generator with finite segmented electrodes is studied theoretically. Numerical two-dimensional calculations are performed for constant, parabolically increasing and parabolically decreasing magnetic induction near the generator exit. The plasma considered consists of argon at 5 atm and 2000°K and seeded with 0.2% cesium. The influence of the described magnetic induction configurations on the current distribution in the MHD-generator exit is studied. The effect of several configurations on the existence of a region near the generator exit with higher electrical conductivity than in the generator itself is discussed. It is preferable to extend the magnetic induction over a distance equal to the generator height, keeping the value of the magnetic induction constant; then the electrical conductivity is not increased near the generator exit and the homogeneous current pattern is hardly disturbed. From the given analysis information is obtained for the design of an appropriate magnetic induction configuration. (auth)

7512 STUDY ON REFRACTORY MATERIALS FOR THE MHD ELECTRIC POWER GENERATION. 6. THERMAL STRESS ANALYSIS OF THE INSULATING DUCT WALLS. Furuse, Yutaka; Hayashi, Yuichiro; Kato, Taizo; Morishita, Tomohiro; Sasagawa, Yoshiaki (Asahi Glass Co. Ltd., Yokohama, Japan). Asahi Garasu Kenkyu Hokoku; 22: No. 1, 17-35(Jul 1972). (In Japanese).

The insulating materials for the semi-hot duct wall of the open-cycle MHD electric power generator are cooled by suitable methods to prevent them from melting and vaporization. But their surface temperature should be kept above 1300°C to avoid electric current leakage by the condensed seed materials. With the purpose of estimating the adaptability of the electrofused magnesia for the duct wall materials, the temperature distributions and resultant thermal stress distributions under steady and unsteady state were calculated by computer. Results of these computations explain generation of the several types of fracture patterns observed in the specimens actually tested and lead to the optimum selection of specimen shape, specimen size, heating rate, and structure of specimen holder. The thermal stress distributions are calculated by the analytical method for the long thin tile, the stress function method for the two dimensional problem, and the finite element method for the tile restrained by copper plate. Two types of holding the specimens were considered: soldering to the water-cooled copper plate, and a mechanical method. The thermal stress distributions in the specimens of each structure were separately analyzed. The following results were obtained after the thermal stress analysis on the mechanically held specimens. The thickness of the specimens should be about 5 mm. The thermal resistivity of thermal boundary layer should be about 25 $cm^2 \cdot sec \cdot °C/cal$. The maximum tensile stress which generates under steady state is less than 400 kg/cm^2 parallel to the hot surface and would not lead to any fatal fracture. To avoid the generating of extremely high thermal stresses, slow temperature increase is required during the heating period. With regard to the soldered specimens, on the other hand, the thickness of them should be more than 14 mm to maintain their surface temperature above 1300°C. The results suggest that the residual stresses which generate during the soldering process are high (about 700 kg/cm^2 at the side end of the specimen-copper plate interface) and that very severe thermal stresses (1600 ~ 2000 kg/cm^2) parallel and perpendicular to the hot surface would generate at the center of the specimen under steady state. From these results, it seems very difficult to avoid the thermal spalling which occurs in the soldered specimens. Consequently, as far as the thermal stress analysis is concerned, the mechanically held specimens are suitable for the semi-hot type insulating duct walls. (auth) (Japan)

7513 ECO-ENERGY STUDIES AT TEMPO. Hausz, W.; Leeth, G.; Meyer, C. Nucl. Eng. Int.; 17: No. 198, 942-5 (Nov 1972).

The basis for an ecologically and economically attractive eco-energy system is illustrated and a number of variations, using nuclear power plants as a primary source, are formulated for each sub-system. An evaluation of the alternative systems is determined, based on the cost and efficiency of each. Some of the problems involved in the process of the conversions from heat to electricity to hydrogen and finally to electricity are considered, especially the disposal of waste heat. It is concluded that foreseeable improvements in the subsystems could make eco-energy economically competitive and ecologically superior to other methods of implementing electric utility systems, within the next 20 years. (UK)

7514 STUDY ON REFRACTORY MATERIALS FOR MHD ELECTRIC POWER GENERATION. 5. THERMAL SHOCK RESISTANCE OF HEATER BED MATERIALS FOR ROTARY TYPE REGENERATOR. Morishita, Tomohiro; Kato, Taizo; Nakamura, Yu; Furuse, Yutaka; Hayashi, Yuichiro (Asahi Glass Co. Ltd., Yokohama, Japan). Asahi Garasu Kenkyu Hokoku; 22: No. 1, 1-16(Jul 1972). (In Japanese).

Theoretical and experimental studies were carried out on thermal shock of the refractory heater bed matrix which would be used for the high-temperature rotary-type regenerator of the magnetohydrodynamic (MHD) electric power generator. This kind of heater bed matrix is required to be highly resistant to thermal shock because it is alternately exposed to high- and low-temperature gas flows in a short cycling period. Analytical treatments were made using a computer to estimate thermal shock resistance of the heater bed matrix. Electrofused mag-

nesia was selected as the material for the heater bed matrix because of its excellent resistance to chemical attack by seed chemicals such as potassium compounds. The heater bed matrix was assumed to be an assembly of hollow cylinders with infinite length. Unsteady temperature distributions and resulting thermal stress distributions within the wall of a hollow cylinder were computed under a thermal condition of the rotary type regenerator. Under these thermal stress distributions, estimations were made of the effects of gas temperature difference, heat transfer coefficient, wall thickness of cylinder, thermal diffusivity of cylinder wall and heating, and cooling periods of time on maximum thermal tensile stresses generated in the wall of the magnesia hollow cylinder. The results of the computations were applied to prepare several kinds of magnesia heater bed matrices. On the other hand, a new apparatus was designed for testing thermal shock resistance of these matrix specimens under the conditions simulating the thermal cycling of the rotary-type regenerator. Using this apparatus, a series of thermal shock tests was carried out on the above-mentioned magnesia heater bed matrices. The thermal cycling conditions under which cracks occurred in the heater bed matrix were obtained from the results of these tests. In order to compare the results of the computations with the thermal shock test results, the maximum thermal stresses were computed on each specimen under the same thermal cycling conditions as those of the tests. The comparison showed the validity of the present study for the design of the heater bed matrix. The most suitable heater bed matrix was selected for the high-temperature rotary-type regenerator of the MHD power generator. (auth) (Japan)

7515 HYDROGEN ECONOMY: AN ULTIMATE ECONOMY. A PRACTICAL ANSWER TO THE PROBLEM OF ENERGY SUPPLY AND POLLUTION. Bockris, J. O'M. (Flinders Univ. of South Australia, Bedford Park); Appleby, A. J. Environ. This Mon.; 1: No. 1, 29-35(Jul 1972).

The present position on energy supply and pollution is surveyed, and it is concluded that present technology will make affluent life increasingly difficult to maintain from about 2000 AD. A totally new energy medium is required. The case is presented for using hydrogen as the medium of energy between remote energy producing sites and population centers—the hydrogen then being used to generate electricity on the site of use or, alternatively, being used directly as a fuel. The effects of a hydrogen economy on all aspects of life requirements are discussed in detail. A hydrogen economy would be entirely non-polluting and would make high energy-densities possible for all regions of the world, thus hastening the spread of uniform high living standards. (auth)

7516 OPTIMIZATION STUDY ON CONSTANT MACH NUMBER MPD GENERATOR. Bartl, J. Strojnicky Cas.; 21: No. 6, 648-64(1970).

Presented and interpreted are extensive results of optimization studies of full-scale constant Mach number MPD power generators based on numerical solution of the constitutive equations. The analysis is based on an assumed steady one-dimensional isentropic compressible flow of an ideal gas in local thermodynamic equilibrium where the working fluid consists of oil combustion products with thermodynamic and transport properties computed from theoretical and empirical relations. Although the study is quite complete and broad in scope, its value would be considerably enhanced had the governing equations been expressed and solved in dimensionless form and the results presented in terms of dimensionless scaling parameters characteristic of the general class of MPD power generators considered. (App. Mech. Rev.)

Facilities and Equipment

Refer also to abstracts 7689 and 8497.

7517 (RISO-M-1536) CONTROLLED SANITARY LANDFILL FOR THE TREATMENT OF NONRADIOACTIVE SOLID WASTES FROM THE RESEARCH ESTABLISHMENT RISOE. Larsen, I. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sep 1972. 12p. (In Danish). Dep. NTIS (U. S. Sales Only).

The background is given for the choice of a controlled sanitary landfill for the treatment of nonradioactive solid wastes from the Research Establishment Risoe. The design principles are commented on. An experimental sanitary landfill has been established at the waste treatment station. Preliminary results for the first nine months of operation of this experiment with regard to the chemical composition of gas and leachate are summarized. (auth)

7518 (SC-RR-720653) EXPLOSIVELY ACTUATED REACTION VESSEL FOR GAS INJECTION AND HIGH VACUUM APPLICATIONS IN PULSED ENERGY EXPERIMENTS. Lynch, A. W.; Meyer, R. T.; Freese, J. M. (Sandia Labs., Albuquerque, N. Mex.). Sep 1972. 8p. Dep. NTIS.

A reaction vessel for studies of the interaction of thermal radiation with materials has been designed for use in the environment of underground nuclear tests. It has been designed for the determination of the vapor composition of vaporized carbon by gas phase, chemical titration procedures. The vessel incorporates an explosive closure of a copper tube for fast sealing (40 μsec) of the reaction chamber after irradiation, a gas-driven shutter valve for high vacuum isolation, and an explosively actuated gas injector to provide a reactive atmosphere. (auth)

7519 FAILURE OF HELICALLY WOUND CABLES IN HIGH FRICTION ENVIRONMENTS. Mitchell, L. A.; Woodall, D. (Central Electricity Generating Board, Berkeley, Eng.). Proc. Inst. Mech. Eng. (London); 186: No. 43, 491-8(1972).

An unusual failure mode has been observed in helically wound cables when operating in high temperature environments without organic lubricants. Surplus strand lengths accumulate at a point along the cable to prevent the cable passing over pulleys and on to a winch. A theoretical explanation for this phenomenon is presented which suggests means by which it may be prevented. Two of these methods have been tested and shown to be successful. (auth)

7520 PERIODIC RESPONSE OF A VISCOELASTIC COOLING TOWER. Langhaar, H. L.; Boresi, A. P. (Univ. of Illinois, Urbana). Nucl. Eng. Des.; 22: No. 1, 75-94(1972).

The periodic response of a linear viscoelastic cooling tower to a prescribed recurring sequence of pressure fluctuations or earth accelerations is analyzed. An approximate analysis, based on the bending theory of shells, is presented. The problem is reduced to a double sequence of boundary-value problems of linear ordinary differential equations. (auth)

7521 ENVIRONMENTAL AIR SAMPLE SCRUBBER (15 Mar 1972) (Engineering Materials). (Goodyear Atomic Corp., Portsmouth, OH). (CAPE-2292).

6 drawings.

The package consists of the drawings and materials list necessary to fabricate an environmental air sample scrubber system used, in a specific case, to detect fluoride ions as hydrogen fluoride (HF) and sulfur dioxide (SO_2) contaminants in air, but also applicable to other gaseous contaminants. The unit consists of pumps, tubing, flow devices, electrical apparatus (110 volt power supply not included), cabinet, and two scrubbers (impingers). Air flows at 0.25 cubic foot per minute through the two 2000 ml scrubbers, containing 1500 ml of sodium tetrachloride mercurate solution in one and 1500 ml of potassium hydroxide solution in the other for SO_2 and HF detection, respectively. Laboratory analyses are subsequently performed to determine the micrograms of contaminant per cubic foot of air. The use of commercially available air scrubbers necessitates a contaminant analysis of the solutions approximately every four days. The capacity of the subject scrubber enables the system to operate continuously for about 28 days before a contaminant analysis is necessary; however, periodic replacement of distilled water lost by evaporation is required. The estimated cost for materials and labor for fabrication of the cabinet, electrical equipment, and scrubber components for one unit is $1500. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 7687, 8979, and 8983.

7522 (CONF-720559-1) DETECTION AND LOCATION OF A NOISE SOURCE IN A DISPERSIVE MEDIUM. Cybula, G. J.; Ledwidge, T. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). 1972. 9p. Dep. NTIS (U. S. Sales Only).

From Electronic instrumentation conference; Hobart, Australia (17 May 1972).

The transit time of a signal in a medium can be measured by many techniques. When the signal has random-like properties then the cross correlation between spaced detectors can, with certain restrictions, yield the transit time between the detectors. A distinction is made between phenomena which are convected by the medium and those which are propagated as a wave motion through the medium. The latter signals may experience a significant dispersive effect and in these cases, the cross correlation of the raw signals yields a result which indicates that between spaced detectors the degree of correlation is zero. A simple theory is postulated to explain these results and meaningful correlations are obtained using only the envelope of the original filtered signals. The results of an experimental programme,

designed to investigate the acoustic frequency spectra generated when a liquid boils in an annular passage, are used to test the method outlined above. Freon was pumped vertically over a heated cylindrical rod mounted inside a circular tube. The signals emanating from the boiling process were detected by piezoelectric accelerometers fastened at either end of the containment tube. Amplitude spectra (plotted with the power supplied to the heated rod as a parameter) clearly indicated the power at which boiling commenced. The position along the tube at which the boiling was active was determined by time delay correlation between the envelopes of the signals from the two accelerometers. (auth)

7523 (RLO-2214-5(Rev.1)) HEAT TRANSFER BY NATURAL CONVECTION BETWEEN VERTICALLY ECCENTRIC SPHERES. Weber, N. (WADCO Corp., Richland, Wash.); Powe, R. E.; Bishop, E. H.; Scanlan, J. A. (Montana State Univ., Bozeman). 1970. Contract AT(45-1)-2214. 26p. (CONF-721112-3). Dep. NTIS.

From American Society of Mechanical Engineers Winter meeting; New York, NY (26 Nov 1972).

Natural convection to a cooled sphere from an enclosed, vertically eccentric, heated sphere is described. Water and two silicone oils were utilized in conjunction with four different combinations of sphere sizes and six eccentricities for each of these combinations. Both heat transfer rates and temperature profiles are presented. The effect of a negative eccentricity (inner sphere below center of the outer sphere) on the temperature distribution was an enhancement of the convective motion, while a positive eccentricity tended to stabilize the flow field and promote conduction, rather than convection. As for concentric spheres, a multicellular flow pattern was postulated to explain the thermal field observed for the largest inner sphere utilized. In all cases the heat transfer rates were increased by moving the inner sphere to an eccentric position, and the utilization of a conformal mapping technique to transform the eccentric spheres to concentric spheres enabled the application of existing empirical correlations for concentric spheres to the eccentric sphere data. It is significant to note that this technique yields a single correlation equation, in terms only of k_{eff}/k and a modified Rayleigh number, which is valid for an extremely wide range of diameter ratios, eccentricities, Rayleigh numbers, and Prandtl numbers. (auth)

7524 HYDRAULIC RESISTANCE FOR AXIAL FLOW IN BUNDLES OF SMOOTH AND RIBBED RODS. Subbotin, V. I.; Gabrianovich, B. N.; Sheinina, A. V. At. Energ. (USSR); 33: No. 5, 889-92(Nov 1972). (In Russian).

Experimental investigation of the hydraulic resistance of bundles of smooth and ribbed rods arranged in a triangular lattice was carried out. An empirical formula for the determination of friction factors of bundles of smooth rods having a relative spacing of $S/d = 1.0$ to 1.5 for $10^4 \leq Re \leq 10^5$ was obtained. The effect of rib spacing on the coefficients of hydraulic resistance of bundles of ribbed rods was investigated. Formulas for calculating coefficients of hydraulic resistance of bundles of ribbed rods having $S/d = 1.0$ to 1.2 and relative rod spacing $T/d = 5$ to ∞ for turbulent fluid flow are given. (auth)

7525 EXPERIMENTAL INVESTIGATION OF AVERAGED CHARACTERISTICS OF TURBULENT FLOW IN CELLS OF ROD BUNDLES. Levchenko, Yu. D.; Subbotin, V. I.; Ushakov, P. A. At. Energ. (USSR); 33: No. 5, 893-9(Nov 1972). (In Russian).

Shear stress distributions on walls and velocity profiles in channels imitating the cells of triangular rod lattices in which $s/d = 1.05$ to 1.1 and 1.2 were measured in experiments with air. Empirical formulas for friction factors and shear stress distributions in regular cells of rod bundles were obtained. The hypothesis regarding the universal character of velocity profiles in channels of complex shape, which is widely used in theoretical studies, was experimentally confirmed. Certain peculiarities of liquid flow processes in modeling channels and regular cells of rod bundles were revealed. (auth)

7526 EXPERIMENTAL STUDY OF EFFECT OF WETTING ON TURBULENT FLOW OF MERCURY IN ANNULI. Hlavac, P. J.; Nimmo, B. G.; Dwyer, O. E. (Brookhaven National Lab., Upton, NY). Int. J. Heat Mass Transfer: 15: No. 12, 2611-31 (Dec 1972).

A basic experimental study of the fluid dynamics and heat transfer characteristics of mercury, in fully developed turbulent flow through annuli, was carried out. The main purposes of the study were to get comparisons between local H and H values, and to determine the effects of wetting on both the fluid dynamics and heat transfer. Results of the fluid dynamics work are presented. Experiments were conducted where the mercury either did not wet at all, or did thoroughly wet, the channel walls. The effects of wetting were found to be appreciable. When both annulus walls were unwetted, the velocity profiles were quite similar to those which have been reported for ordinary fluids. When only the inner wall was wetted, the radius of maximum velocity moved considerably outward (i.e. toward r_2) from what it was when both walls were unwetted, and when both walls were wetted, the radius of maximum velocity also moved outward, but not so far as that for the situation where only the inner wall was wetted. These differences in flow behavior are reflected in the u^+ vs $\ln y^+$ relationships and the M profiles. Wetting was found to have a large influence on the u^+ vs $\ln y^+$ relationship for the inner portion of an annulus. The eddy diffusivities of momentum transfer were correlated only moderately well by modified forms of the Kays–Leung and Eifler correlations. It is shown that the ratio of the maximum value of M in the inner portion of an annulus to that in the outer portion is an explicit function of the radius ratio and is independent of Reynolds number. (auth)

7527 ROUGH ANNULUS PRESSURE DROP. INTERPRETATION OF EXPERIMENTS AND RECALCULATION FOR SQUARE RIBS. Maubach, K. (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Heat Mass Transfer; 15: No. 12, 2489-98(Dec 1972).

A method is presented which enables pressure drop measurements with rough tubes, annuli and parallel plates to be interpreted. A parameter deduced describes the effect of roughness on a turbulent velocity profile. As a result, experimental data for various degrees of roughness and channel geometries can be generalized and made comparable. The results of the interpretation of data for rectangular cross section roughnesses given by numerous workers are summarized. Finally, examples of the recalculation of friction factors are shown, provided that Reynolds numbers of the flow, channel and roughness geometries are given. The results prove that by the method proposed friction factors of isothermal turbulent flow in concentric annuli with rough inner tubes can be calculated with a precision which is sufficient for design problems. (auth)

7528 PRESSURE DROP PERFORMANCE OF ROD BUNDLES IN HEXAGONAL ARRANGEMENTS. Rehme, K. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Int. J. Heat Mass Transfer; 15: No. 12, 2499-2517(Dec 1972).

Systematic investigations were carried out on the pressure drop for incompressible, isothermal, fully developed turbulent flow in rod bundles with hexagonal arrangement of rods. The results of measurements of the pressure drop over a range of Reynolds numbers from $Re = 6 \times 10^2$ to 2×10^5 in 25 test sections are presented. The rods with rod distance ratios of $P/D = 1.025$ to 2.324 were surrounded by hexagonal channels. The numbers of rods were 7, 19, 27 and 61, respectively. The results are compared with more than 60 other published experimental and theoretical results on pressure drop coefficients in rod bundles. The conclusions were: pressure drop coefficients for laminar flow calculated on the basis of earlier work are confirmed by the experiments; a critical Reynolds number could not be detected for most of the test sections; with turbulent flow there is an upper limit for the pressure drop coefficient, the "equivalent" annular zone solution; the pressure drop coefficient quickly rises from approximately 60% of the circular tube value for closely packed rods ($P/D = 1.0$) to the circular tube value for $P/D = 1.08$; for even higher rod distance ratios, the pressure drop coefficients rise a little to about 10% above the circular tube values at $P/D = 2.0$. The number of rods in a rod bundle has no measurable effect on the pressure drop coefficient. (auth)

7529 RADIATIVE HEAT TRANSFER BY FLOWING MULTIPHASE MEDIUM. PART 1. AN ANALYSIS ON HEAT TRANSFER OF LAMINAR FLOW BETWEEN PARALLEL FLAT PLATES. Echigo, R.; Hasegawa, S. (Kyushu Univ., Fukuoka). Int. J. Heat Mass Transfer; 15: No. 12, 2519-34(Dec 1972).

The multiphase flow of gaseous suspensions of fine particles furnishes high heat transfer characteristics at high and/or extremely high temperatures and at high heat fluxes due to the radiative transfer from heat source to suspensions. The phase shift of particulate media greatly improves the overall heat transfer and has important practical industrial applications. The behavior of the suspensions and the heat transfer mechanism in flowing multiphase media is examined. An analysis is carried out on the laminar flow between parallel plates by taking into account thermal radiation. The results illustrate the temperature profiles of fluid and dispersed phase, respectively, and the heat transfer characteristics for the wide ranges of dimensionless parameters such as conduction-radiation interaction parameter, loading ratio of particles, optical depth of duct and heat transfer between the two phases. Reference to the temperature profiles reveals the facts that while the temperature gradient in the vicinity of the heating surface increases due to the presence of particulate phase, the cup-mixing mean temperature is raised appreciably by thermal radiation through the dispersed medium. In consequence, the contributions of suspensions on heat transfer

are drastic, particularly in high temperature cases. Correlations between the foregoing dimensionless parameters are also examined. (auth)

7530 FORCED CONVECTIVE HEAT TRANSFER TO SUPERCRITICAL WATER FLOWING IN TUBES. Yamagata, K.; Nishikawa, K.; Hasegawa, S.; Fujii, T.; Yoshida, S. (Kyushu Univ., Fukuoka). Int. J. Heat Mass Transfer; 15: No. 12, 2575-93(Dec 1972).

Experimental investigations were made of heat transfer to supercritical water flowing in a horizontal tube and vertical tubes. A comprehensive set of data was obtained for pressures from 226 to 294 bar, bulk temperatures from 230 to 540°C, heat fluxes from 116 to 930 kW/m^3 and mass velocities from 310 to 1830 kg/m^2s. Because the physical properties of supercritical fluids change rapidly with temperature in the pseudocritical region, the heat transfer coefficients show unusual behavior depending upon the heat flux. At low or moderate heat fluxes relative to the flow rate, a satisfactory correlation was obtained, which predicts reasonably well the enhanced heat transfer coefficients near the pseudocritical point. The several characteristics of the deterioration in heat transfer which occurs at high heat fluxes were clarified, and the limit heat flux for the occurrence of the deterioration was determined in connection with the flow rate. (auth)

7531 RADIATIVE HEAT TRANSFER BY FLOWING MULTIPHASE MEDIUM. PART 2. AN ANALYSIS ON HEAT TRANSFER OF LAMINAR FLOW IN AN ENTRANCE REGION OF CIRCULAR TUBE. Echigo, R.; Hasegawa, S.; Tamehiro, H. (Kyushu Univ., Fukuoka). Int. J. Heat Mass Transfer; 15: No. 12, 2595-2610(Dec 1972).

Radiant heat transfer by flowing gaseous suspensions of solid and/or liquid fine particles in an inlet section of circular tube is analysed. Results on temperature profiles of both phases and heat transfer parameters illustrate that the multiphase medium is pertinent to heat transfer at high and extremely high temperatures because of the absorption behavior of the dispersed phase for thermal radiation. The results are summarized for wide ranges of parameters such as loading ratio, heat transfer characteristics between two phases, optical thickness of a duct, interaction parameter of conduction with radiation, etc. The interactions between convection to fluid and radiation are then examined in some detail. (auth)

Materials Testing

7532 (Y-1853) IMPROVING THE Y-12 NEUTRON RADIOGRAPHY FACILITY. Murray, E. M.; Telford, J. L. (Oak Ridge Y-12 Plant, Tenn. (USA)). 18 Nov 1972. Contract W-7405-eng-26. 18p. Dep. NTIS.

To improve the Y-12 Neutron Radiography Facility, a series of four experiments were conducted. The factors which appeared to be most important for this facility have been identified and the best operating conditions determined. The overall improvement made was quite significant. (auth)

Nuclear Explosions

Refer also to abstract 7567.

7533 (AD-740819) VARIATION OF SHOCK FRONT PROPERTIES FROM A 1-KT. EXPLOSION WITH ALTITUDE. Kownacki, E. J. (Defense Nuclear Agency, Washington, D. C.). Jul 1971. 39p. (DNA-2714-T). NTIS.

A computer program was developed to present shock front properties in the form of isovalues as functions of altitude of burst and range. This program consisted of a Sachs' scaling routine and a log-log interpolation routine. It was found that overpressure, density, and ρ-U decrease with increasing altitude; particle velocity, density ratio, pressure ratio, and shock strength increase with increasing altitude; thermal flux density and dynamic pressure remain relatively unchanged with increasing altitude. (auth) (GRA)

7534 (AD-741876) SOME FUNDAMENTAL ASPECTS OF NUCLEAR WEAPONS. Technical Report, June-August 1971. Cooper, H. F. Jr.; Leigh, G. G.; Brode, H. L. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Mar 1972. 48p. (AFWL-TR-72-19). NTIS.

Nuclear weapons effects associated with a surface burst geometry, particularly on a rock medium, are summarized. Particular emphasis is placed on the close-in blast and shock phenomenology that usually is the bounding factor limiting the potential hardness of protective structures. Consideration is given to the coupling of energy into the air and earth in the vicinity of ground zero, the close-in airblast and ground shock, and the subsequent environment usually occurring at ranges of strategic interest. (auth)

7535 (NVO-118) PROCEEDINGS OF THE STRUCTURAL RESPONSE SEMINAR, LAS VEGAS, NEVADA, 25 AUGUST 1971. (Nevada Operations Office (AEC), Las Vegas. Office of Effects Evaluation). Aug 1972. 154p. (CONF-710841). Dep. NTIS.

Five papers were presented at the conference. A separate abstract was prepared for each paper. (L.C.L.)

For abstracts of individual papers see: 7536-7540.

7536 (NVO-118, pp 7-54) STRUCTURAL DYNAMIC THEORY. Blume, John A. (John A. Blume and Associates, San Francisco). Aug 1972.

From Proceedings of the structural response seminar, Las Vegas, NV (25 Aug 1971).

The Structural Response Program includes the measurement and analysis of the response of whole buildings and other structures to actual ground motions caused by earthquakes or underground nuclear explosions. The purpose of the program is to develop simple relationships for predicting structural response and damage based on both theory and empirical data. Examples are given of structural response theory and data acquired during several nuclear events and earthquakes. It was found that: buildings respond according to dynamic principles, as expected; they often have considerable amplification of upper level response over that of the peak ground motion; low buildings are frequently built with an excess of strength against lateral motion whereas high-rise buildings are apt to barely meet seismic safety standards; real buildings are difficult to model reliably due to the complexity of the structures as built and the nonlinear characteristics of the structure; and much valuable information about the nonlinear characteristics of real buildings has been obtained in the Structural Response Program. (L.C.L.)

7537 (NVO-118, pp 55-77) NATURE OF DAMAGE PREDICTION FOR LOW-RISE BUILDINGS. Scholl, R. E. (John A. Blume and Associates, San Francisco). Aug 1972.

From Proceedings of the structural response seminar, Las Vegas, NV (25 Aug 1971).

Based on a comparison of the motion-damage relationships empirically derived from the Project Rulison underground nuclear explosion gas stimulation experiment with previously determined damage thresholds and deterministic damage threshold criteria, it appears that the first provides a sound probabilistic basis for predicting damage to low-rise buildings caused by underground explosions. The statistical model described in preceding sections has been developed quite generally for predicting damage to low-rise buildings caused by ground motion. Thus, the procedure is designed to be applicable for all types of ground motion causes, e.g., underground nuclear explosions, earthquakes, and high explosives. (auth)

7538 (NVO-118, pp 79-112) INFLUENCE OF NONSTRUCTURAL PARTITIONS ON STRUCTURAL DYNAMIC RESPONSE CHARACTERISTICS. Raggett, Jon D. (John A. Blume and Associates, San Francisco). Aug 1972.

From Proceedings of the structural response seminar, Las Vegas, NV (25 Aug 1971).

A study was undertaken to experimentally measure how nonstructural partitions affect the dynamic response characteristics of a structure and to predict those effects theoretically and/or empirically. The effects measured or predicted were the variations in the natural periods and the damping ratios of the structure. The data were obtained from two reinforced concrete four-story test structures at the Nevada Test Site. The modeling procedures are discussed and theoretical results are compared with data from pull tests, vibrator tests, and underground nuclear explosion records. It was concluded that: gypsum board partitions contribute little stiffness to the total structure but significantly affect the overall damping of the structure; unreinforced masonry infilled walls have extreme but shortlived stiffness with the actual stiffness depending on the prior vibration history; and the dynamic response characteristics of the structures tested were extreme due to the magnitude of ground motions at the NTS and would be less extreme under more moderate ground motion conditions. (L.C.L.)

7539 (NVO-118, pp 113-30) STATISTICAL ANALYSIS OF RULISON LOW-RISE BUILDING DAMAGE. Farhoomand, Iraj (John A. Blume and Associates, San Francisco). Aug 1972.

From Proceedings of the structural response seminar, Las Vegas, NV (25 Aug 1971).

Prediction of damage to low-rise buildings is necessary for the evaluation of structural effects and safety hazards associated with projects requiring the use of underground nuclear devices.

The Project Rulison gas stimulation experiment in western Colorado provided useful data for determining motion-damage relationships. Data on the ground motion, structure, and damage obtained from Rulison were employed to develop a simple and fast procedure for predicting such damage. (auth)

7540 (NVO–118, pp 131-48) SPECTRAL MATRIX METHOD OF DAMAGE PREDICTION. Monroe, Robert E. (John A. Blume and Associates, San Francisco). Aug 1972.

From Proceedings of the structural response seminar, Las Vegas, NV (25 Aug 1971).

The Spectral Matrix Method for predicting the damage to structures from ground motions caused by underground nuclear explosions is described. Damage is defined as permanent changes in the physical properties of the structures. In order to predict the damage, it is necessary to predict the ground motion, derive structural response related to the input ground motion, and develop relationships between the structural response and structural damage. This information was used with field survey data on explosions at the Nevada Test Site to develop an actual damage prediction. (L.C.L.)

7541 (NVO–1163-TM-25) VARIABILITY OF GROUND MOTION MODELS: THE TRANSMISSION PATH. Lane, Stephen (Environmental Research Corp., Las Vegas, Nev.). Apr 1971. 47p. Dep. NTIS.

The problem of finding the maximum credible ground motion from an underground nuclear detonation is approached by dividing the earth, or wave propagation system, into a source region, a transmission path, and a recording site. Some of the known characteristics of the source and recording site are discussed. Requirements on a model for the less well understood transmission path are specified; a model is proposed which meets them. This idealized model exhibits formation of a caustic due to a focusing action at the Mohorovicic discontinuity. Ground velocities on the caustic may be significantly larger than at nearby distances for the equivalent yield, without a caustic. Recommendations for further study of all three regions of the wave propagation system are made. (auth)

7542 (ORO–4201-2) AN INVESTIGATION OF TRITIUM DECONTAMINATION. Final Report. Wethington, J. A. Jr. (Florida Univ., Gainesville. California Univ., Livermore. Lawrence Livermore Lab.). 1972. Contract AT(40-1)-4201. 32p. Dep. NTIS.

The stimulation of gas wells by nuclear explosions produces T-containing gas and water. Exchange reactions can be used to decontaminate these materials. The T-content of H_2O was reduced by contact with certain sandstones, shales, and clays. Exposure was at room temperature or at elevated temperatures. Contact with other sandstones, other clays, grandiorite, etc., resulted in little decontamination. No exchange between HTO and CH_4 was observed up to 300°C unless a catalyst was present. Certain rocks were found to have intrinsic catalytic activity. Rhodium on alumina, Pt on alumina, Wilkinson's catalyst, Pt^{+2}, and Pt^{+4} were all excellent exchange catalysts. Because of current interest in the Rio Blanco experiment, a sandstone and a shale from the site were tried. The T-content of water was not reduced, and the samples showed no catalytic activity for the exchange reaction. (auth)

7543 (PNE-WW–14) GEOLOGY OF PROJECT WAGON WHEEL NUCLEAR STIMULATION PROJECT. Shaughnessy, J.; Butcher, R. H. (El Paso Natural Gas Co., Farmington, N. Mex.). 1972. 30p. Dep. NTIS.

Wagon Wheel is a project planned to stimulate gas reservoirs of the Pinedale Anticline by means of nuclear explosives. The Pinedale Field, located in the northern portion of the Green River basin of southwest Wyoming, is potentially productive from nearly 10,000 feet of lower Fort Union, Lance–Lewis, and Mesaverde equivalent sandstones. Attempts to produce the field conventionally have proved uneconomical due to low permeability. The first nuclear stimulation experiment was Gasbuggy, in northwest New Mexico, detonated in 1967 using a 29 kiloton explosive. Technical questions answered by Gasbuggy resulted in the program at Wagon Wheel, which is an actual attempt at economic use of nuclear energy. Wagon Wheel No. 1 was drilled to 19,000 feet to evaluate the entire Mesaverde section. Gas was detected on mud logging equipment throughout the basal Fort Union, Lance–Lewis and Mesaverde, below the top of the gas reservoir at 7,972 feet. The well has been plugged back to 11,700 feet as a possible emplacement hole in which five 100 kiloton explosives will produce a chimney from 9,000 to 11,650 feet. Reserves in this interval are calculated at 207 billion cubic feet of gas in place per square mile. Extensive logging, coring and testing have been carried out in the program, including special logs for rock mechanics study. Cores were compared to Gasbuggy with regard to rock strength, shear behavior and potential fracture formation. Two special wells in addition to the Wagon Wheel No. 1 were drilled for the primary purpose of evaluating the aquifers above the gas reservoir. Potable water extends to a depth of 3,730 feet. Salt water occurs from 3,730 to 5,630 feet. Low quality subpotable water extends from 5,630 to 7,140 feet. The salt water zone is interpreted to be a tongue of Wasatch extending from the west into Eocene arkoses derived from the Wind River Range to the east. Plans call for sequential detonation of five explosives spaced at intervals from 9,220 to 11,570 feet, to produce a more or less continuous chimney from 9,00 to 11,650 feet. There will be a safety margin of 1,600 feet between the top of fractures and the bottom of the known aquifers. (auth)

7544 (PNE-WW–15) PROJECT WAGON WHEEL INTERIM REPORT OF WAGON WHEEL NO. 1 AT CASING POINT DEPTH OF 12,106 FEET. Shaughnessy, J.; Butcher, R. H. (El Paso Natural Gas Co., Farmington, N. Mex.). Apr 1970. 36p. Dep. NTIS.

The Wagon Wheel Event is an experiment to test the feasibility of using underground nuclear explosions to stimulate natural gas production from sandstone deposits near Pinesdale, Wyoming. The Wagon Wheel test hole No. 1 was drilled to provide a possible nuclear stimulation site and tests were performed to obtain cores, drill-stem tests, drill cutting samples, and wireline surveys for prediction of nuclear effects, prediction of radioactivity in the gas to be produced, and definition of the reservoir properties. In addition to the predictions based on the physical and mechanical properties of the rock, hydrologic tests were required to define the location and characteristics of the ground water in sufficient detail to allow the design of a nuclear reservoir stimulation test which would not contaminate potable ground water and/or permit excessive water to enter a resultant nuclear chimney. A summary of the Hole No. 1 test data to a depth of 12,106 ft is presented and includes data on: hydrologic conditions; fracture properties of the rock, temperatures at different depths; drill core composition; well logging measurements; expected gas yield; porosity and water saturation; and permeability. (L.C.L.)

7545 (PNE-WW–16) COMPLETION REPORT, WAGON WHEEL WATER WELL NO. 2. Shaughnessy, J. (El Paso Natural Gas Co., Farmington, N. Mex.). Jul 1971. 48p. Dep. NTIS.

Wagon Wheel Water Well No. 2 was drilled to evaluate preselected aquifers in the medial Tertiary between 4937 and 5108 feet and a shallow zone between 2312 and 2427 feet. Each test was programmed to determine the productivity rate, static fluid level, a possible injection rate of fluid into the reservoir and to secure a water sample for chemical, radiometric (gross alpha and gross beta), and carbon 14 (age dating) analyses. Tests of the two zones will provide additional data to supplement information already obtained from the drilling and testing program performed on Wagon Wheel Water Well No. 1 and Wagon Wheel No. 1. A nine inch hole was drilled to 5200 feet and cased with seven inch pipe cemented to the surface. Prior to perforating the lower zone, a Sperry Sun Gyroscopic multishot directional survey was run to 100 points from surface to a depth of 5151 feet. Wireline logging of the open hole was accomplished to select the sandstone reservoirs to be tested. A gamma ray correlation log and collar locator was run to locate the selected intervals to be perforated. The results of this hydrological study and hydrological data from Wagon Wheel Water Well No. 1 and Wagon Wheel No. 1 confirm that to a depth of 7140 ft: the area aquifers are stratigraphically independent and not vertically connected by fractures; potable water overlies saline water which in turn overlies subpotable water; and the aquifers originate from different lithographic units. Data from flow rate measurements, water analyses, and injection testing are also included. (L.C.L.)

7546 (PNE-WW–17) PROJECT WAGON WHEEL HYDROLOGICAL TEST PROGRAM, SUBLETTE COUNTY, WYOMING. Shaughnessy, J.; Voegeli, P. T.; Emerson, D. O.; Fenske, P. R. (El Paso Natural Gas Co., Farmington, N. Mex.). 8 Apr 1970. 32p. Dep. NTIS.

The Wagon Wheel hydrological testing program was performed to provide hydrological data over a portion of the 7250 ft of water-yielding sandstones beneath the Wagon Wheel No. 1 test site. Wagon Wheel Water Well No. 1 was tested to 2500 ft. The test procedures are described. These tests confirmed that producible water is present from 130 ft down to 2500 ft. Drill-stem tests were performed for the intervals between 7250 ft to 7400 ft and 7400 ft to 7970 ft. The data produced define the physical parameters of the aquifers from the surface to 7150 ft and indicate that intervals will yield water. Further work is required to evaluate the water flow direction and rate of travel thereby providing data for estimating the transport of any contaminants entering the ground water system. Electrical conductivity measurements of water samples

indicate that potable or near potable water occurs at a depth of 7250 ft. (L.C.L.)

7547 (PNE-WW-18) COMPLETION REPORT, WAGON WHEEL WATER WELL NO. 1. Shaughnessy, J. (El Paso Natural Gas Co., Farmington, N. Mex.). Sep 1969. 18p. Dep. NTIS.

Wagon Wheel Water Well No. 1 was drilled to obtain an adequate water supply to sustain a drilling program and to provide reliable information for the hydrological study. These two items were achieved by the completion of Wagon Wheel Water Well No. 1. The $9\frac{7}{8}$ in. hole size provided a small diameter hole to adequately acquire sediments for both physical and chemical identification as well as contribute towards the procurement of reliable electric logs for the interpretations of porosity, permeability and water saturation. In addition, the 2500 ft test determined if there were gas communications within the shallow sandstones from the deep productive intervals of the Pinedale No. 5 Unit. A small amount of gas, too small to measure, was detected while the water well was undergoing pump tests. The origin of the low pressure gas is from the perforated sands and is considered to be gas in place. There were no abnormal pressures or flows of natural gas which would require the use of blow out preventors while drilling Wagon Wheel No. 1. The gas will not flow from the well unless the pump is in operation. The water well is presently shut in with a potential of 1600 barrels of water per day. The well was completed with the installation of a 1000 barrel per day electric pump. Analysis of the recovered water showed that the water can be used for the designed purposes and is safe for human consumption. (auth)

7548 TEMPERATURE IN A CHIMNEY FORMED BY AN UNDERGROUND NUCLEAR EXPERIMENT. Parks, D. E. (Systems, Science, and Software, La Jolla, CA). Nucl. Technol.; 16: No. 3, 543-55(Dec 1972).

A model was developed to explore the late-time evolution of temperature in the rubble-filled chimney that is formed following the collapse of the cavity produced by an underground nuclear detonation. It is assumed that thermal convection currents sustained by energy from a hot solidified melt at the bottom of the chimney circulate sufficiently rapidly that within a few weeks after the explosion they are able to maintain the chimney as an isothermal region. On the time scales of interest (months) the temperature of this region is governed by heat conduction into the initially cold rock surrounding the chimney and melt. The model, when applied to the Gasbuggy and Rulison chimneys, is capable of predicting temperatures which compare favorably with experiment, and allows rapid exploration of sensitivity of chimney temperatures to variations in physical and geometric parameters. The sensitivity of calculated temperatures in Gasbuggy to uncertainties in geometrical factors (radius, etc.), the spatial partition of thermal energy produced by the blast, and the physical properties of the rock (density, specific heat, thermal conductivity) is determined. Finally, having calibrated the model against Gasbuggy and Rulison experiments, it is estimated that temperature increases in the anticipated chimney formed by the proposed Wagon Wheel experiment will be in the range 550 to 725°F in the 1 to 24 month period following the event. These temperatures are much higher than those in Gasbuggy and Rulison, and raise questions of the occurrence of CO_2-producing reactions throughout the Wagon Wheel chimney volume. The implications of these high temperatures for gas production equipment should be investigated. (auth)

7549 SOCIOECONOMIC ASPECTS OF A PLOWSHARE PROJECT. Otway, H. J. (Los Alamos Scientific Lab., NM); van der Harst, Leo; Higgins, G. H. Nucl. Technol.; 17: No. 1, 58-65(Jan 1973).

The creation of a natural gas storage facility by nuclear explosives has been examined from a cost-benefit standpoint. Monetary equivalent estimates were made for the inconvenience, both physical and psychic, caused by ground shock from the detonations and for biological effects of statistically expected radiation exposures. Benefit-risk ratios were calculated for three groups; the industrial sponsor, society as a whole, and the social group residing within the range of the physical awareness of ground shock. For the industrial sponsor the benefit-cost ratio, depending upon his tax situation, falls between 1.7 and 2.5. For the larger societal group, the benefit-risk ratio is found to be 30 to 50. For the nearby population, who bear most of the risks, this ratio is estimated to be about 6. However, if the local group perceives this ratio to be lower, opposition to the project may develop, thereby affecting the economic benefit-cost ratio for the industrial sponsor. Depending upon the magnitude of the disutilities, as perceived by the local population, the industrial sponsor may attempt to increase the perceived benefit-risk ratio by providing additional real benefits or by an informational-educational program designed to bring perceived risks in with real risks. (auth)

Protective Structures and Equipment

Refer also to abstract 7556.

7550 (CALT-822-47) ELECTRICAL RESISTIVITY AND CURIE TEMPERATURE OF AMORPHOUS (Fe-Ni)-P-C ALLOYS. Hasegawa, R.; Dermon, J. A. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Nov 1972. Contract AT(04-3)-822. 10p. Dep. NTIS.

Respirator filter cartridges are routinely tested under steady-flow conditions to provide a basis for predicting their future performance under cyclic-flow conditions produced by various human breathing efforts. Because filter efficiency is a function of velocity, as well as particle size, it was considered necessary to perform tests to define aerosol penetration through respirator filter cartridges under both cyclic- and steady-flow conditions. These tests effectively evaluate the adequacy of existing steady-flow test procedures. A breathing pump was used to simulate different human breathing patterns during work ranging from sedentary to extra heavy. Steady-flow conditions were identical to those recommended by the Bureau of Mines for permissibility tests of respiratory protective devices. Solid, monodisperse, polystyrene latex aerosols ranging from 0.176 to 2.02 μm in size, as well as liquid monodisperse 0.3-μm dioctyl phthalate were used as the test aerosols. A method was devised to sample during cyclic flow without altering the flow pattern by sampling continuously downstream from the respirator cartridge. Experimental data obtained during steady and cyclic flow are compared as a function of aerosol size, breathing pattern, and type of aerosol. Theoretical steady-flow aerosol penetration through fibrous filters is compared to penetrations associated with variable velocities produced during cyclic flow. (auth)

Safety Engineering

7551 (IDO-22052) PROBABILITY OF EXCEEDING CAPACITY OF FLOOD-CONTROL SYSTEM AT THE NATIONAL REACTOR TESTING STATION, IDAHO. Carrigan, P. H. Jr. (Geological Survey, Idaho Falls, Idaho. Water Resources Div.). Jan 1972. 110p. Dep. NTIS.

The present flood-control system at the National Reactor Testing Station consists of earth-fill embankments which partially dam flow in the Big Lost River, near the southwest corner of the station, and which confine the flow diverted at the dam to four spreading grounds (connected in series). Water passing through the dam flows northeastwardly in the river to accumulate in four dry lakes (terminus of the river). Water diverted into the spreading grounds may spill onto unimproved private lands. Analyses of historical streamflow information indicate that floods in the Big Lost River would overtop the flood-control diversion dam about once every 55 years on the average; if the culverts in the dam are completely plugged, overtopping of the dam would occur about once every 16 years. Effects of synthetically generated snowmelt floods on the flood-control system have been analyzed. These analyses indicate that the diversion dam will not be overtopped by a 300-year flood if the capacity of the diversion to the spreading grounds is doubled. The analyses also suggest that doubling the capacities of channels connecting spreading grounds would be prudent. (auth)

Vacuum Engineering

Refer also to abstracts 7518, 7700, and 7881.

7552 APPLICATIONS OF VACUUM TECHNIQUES. Peuch, M. A.; Gervais, R. (CEN, Grenoble, France). Vide; 27: No. 158, 105-7(Mar 1972). (In French).

The principles of the techniques used to join different materials used in the construction of various equipment at the Grenoble nuclear research center are presented. The vacuum housed electron gun (2.10^{-5} torr) used for vacuum electron beam welding is described. Equipment used for vacuum brazing is also described. Brazing effected by the capillary flow of the brazing metal in the joint or by the formation of a eutectic at the interface enables similar or different metals to be joined. (France)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

7553 ENVIRONMENT OF WYOMING TERTIARY URANIUM DEPOSITS. Rackley, R. I. Amer. Ass. Petrol. Geol. Bull.; 56: No. 4, 755-74(1971).

Four major uranium districts in Tertiary rocks of central Wyoming are in fluvial sandstones derived from the granitic rock of the ancestral Sweetwater arch and deposited in adjacent intermontane basins. Sediment transported southward into the Great Divide basin was deposited on an apron of alluvial fans. Sedimentation in the Gas Hills area of the Wind River basin was on an alluvial fan in which ridges of older rock disrupted the normal development of the fan. Sediment in west Shirley basin was deposited on an alluvial fan, but in east Shirley basin and in the Powder River basin sedimentation was channel and flood-basin deposits of a meandering stream. The sandstones are subarkosic to arkosic, medium grained to conglomeratic, angular and poorly sorted. Sandstones intertongue with green or carbonaceous shales. Sedimentation was in a warm, humid climate with abundant vegetation. Decay of the organic material created reducing conditions in the sediment which caused partial carbonization of some of the plant debris, formation of pyrite, and precipitation of uranium minerals. Following burial, uplift-induced changes in the hydrodynamic system caused an invasion of the reduced sediment by oxygenated water far below the static water table. This caused destruction of carbonaceous material, oxidation of pyrite, and accumulation of uranium and other susceptible metals in a wave or front just ahead of the invading oxidizing environment. The invading oxidation was a dynamic, expanding process which moved through the permeable zones of the fluvial sequence until its dimensions measured miles in areal extent and hundreds of feet in thickness. This geochemical cell had a sharply defined boundary produced by biochemically controlled changes in physical and chemical conditions. Oxygenated waters, aided by Thiobacillus ferrooxidans, oxidized pyrite to produce sulfuric acid and ferric sulfate, a strong oxidizer, which leached uranium and other susceptible elements. In the reducing part of the cell, anaerobic bacteria, including the sulfate reducer Desulfovibrio, consumed the organic material in the sediments and the sulfates from the oxidizing area, to produce hydrogen, hydrogen sulfide, and a mildly alkaline, strongly reducing environment which precipitated pyrite, uranium, and other metals on the front. Migration of the cell was controlled by the permeability of the sandstone and by availability of carbon and pyrite. The cell advanced faster in the more permeable zones and was retarded in zones of reduced permeability and areas of greater pyrite and carbon content. The position of the mineral front was a function of the initial sedimentary pattern. Sedimentation, alteration, and mineralization in the Gas Hills and Shirley basin districts illustrate these conditions and processes. (auth)

7554 URANIUM: ROSSING MOVES AHEAD, AND PLANS ARE MADE FOR ENRICHMENT. Eng. Mining J.; 173: No. 11, 188-9(Nov 1972).

Production of uranium in South Africa and Southwest Africa is reviewed. It is noted that deposits in these areas are estimated at 300,000 tons. The quantities of uranium sold by South Africa are secret. Other information is available and is presented concerning U_3O_8 production plans and on exploration. Especially emphasized are explorations in the Rossing area in Southwest Africa. (J.R.D.)

7555 PALABORA'S NEW HEAVY MINERALS PLANT ADDS URANIUM CONCENTRATE TO THE RECOVERY LIST. Nel, V. (Palabora Mining Co. Ltd., South Africa). Eng. Mining J.; 173: No. 11, 186-7(Nov 1972).

A gravity concentration plant for use in a process involving chemical extraction applicable to uranothorianite concentrates is described. The plant is used to produce uranium oxide. Descriptions are included on gravity concentration, chemical extraction, and health safeguard procedures. (J.R.D.)

Radioactive Effluents

Refer also to abstracts 7490, 7501, 7502, 7559, 7757, 7803, 7952, 9071, 9078, 9082, 9098, 9100, 9104, and 9108.

7556 (BNWL-SA-4418) [OPEN END DISCUSSION FOR PROCEEDINGS OF AIR CLEANING CONFERENCE (U.S.A.E.C.)]. Craig, D. K. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. 4p. (CONF-720823-15). Dep. NTIS.

From 12th air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

The relation between particle size and filtration, particularly as it relates to plutonium oxide aerosols, is discussed. The effects of electrostatic charge and relative humidity on filter efficiency are also discussed. Mention is also made of the decontamination factor of a filter and its relative importance to environmental contamination. (E.R.B.)

7557 RADIONUCLIDES IN RIVER SYSTEMS. Nelson, D. J.; Kaye, S. V.; Booth, R. S. (Oak Ridge National Lab., TN). pp 367-87 of River Ecology and Man. /Oglesby, R. T. (ed.). New York; Academic Press, Inc. (1972).

From International symposium on river ecology and the impact of man; Amherst, Mass. (20 Jun 1971). See CONF-710610.

The sources, transport, and fate of radioisotopes released to rivers, and the potential radiation doses to man utilizing the Clinch River for drinking water, fisheries, and recreation are discussed. Among the sources of radionuclide release are: nuclear power stations; fuel reprocessing plants; AEC-sponsored production and research laboratories; nuclear weapons testing; medical institutions; university and industrial research laboratories and reactors; and peaceful nuclear explosions. The environmental fate of radionuclides released to rivers includes transport in streams and concentration by aquatic organisms. (E.R.B.)

Radioactivity Monitoring and Transport

Refer also to abstracts 7501, 7542, 7557, and 7580.

7558 (ICP-1013) EVALUATION OF HAZARDS AND CORROSION OF BURIED WASTE LINES IN NRTS SOILS. Paige, B. E.; Siedenstrang, F. A.; Niccum, M. R. (Allied Chemical Corp., Idaho Falls, Idaho. Idaho Chemical Programs Operations Office). Sep 1972. Contract AT(10-1)-1375. 247p. Dep. NTIS.

Following the cataloging of buried waste lines at the National Reactor Testing Station (NRTS), the potential hazard for contaminating the environment was evaluated. The hazard level was based on the nature of the waste carried, and the potential for contamination was based on the frequency of use, the construction of the pipeline, and existing monitoring for leaks. Soils at NRTS sites were reviewed for formation, mineralogy, permeability, moisture content, aeration, and other features which affect soil corrosivity. Soil samples were analyzed for soluble ion content, soil resistivity, moisture equivalent, and particle size for comparison to National Bureau of Standards data on soil corrosivity. Based on these data and examinations made during this study, the corrosion of carbon steel, cast iron, and stainless steel is compared for different types of NRTS soil. Detection of leaks at the ground surface and infiltration of liquid from corrosion-type leaks are described. Methods and equipment for leak detection are described. Encasements, which protect highly radioactive waste lines from external corrosion and provide monitoring capabilities, are discussed; details of existing encasements at the Chemical Processing Plant are presented. Cathodic protection, a method for preventing underground corrosion of metal waste lines buried directly in the soil, is discussed. Existing cathodic protection systems and means of upgrading them to prevent leaks in buried waste lines are described. (auth)

7559 (NP-19610) MARINE ENVIRONMENTAL QUALITY. (National Academy of Sciences, Washington, D. C.). 1971. 118p.

A study of marine environmental quality was carried out by the Ocean Science Committee of the Ocean Affairs Board of the National Science Foundation. The study reviewed the current status of knowledge of ocean pollution, identified areas requiring additional research, and established priorities for research efforts. Results are discussed under the following headings: fluxes of materials to the marine environment; dispersal and transport of pollutants in the marine environment; biological exchange processes in relation to marine environmental quality; effects of pollution on marine organisms; and the ultimate fate of substances that relate to the quality of the marine environment. Nuclear weapons testing and nuclear power programs as a source of artificial radionuclides in the marine environment are discussed. Disposal of fission products in the ocean in the future is discussed and it is pointed out that during transport, marine organisms will remove insignificant amounts of radionuclides. (H.L.W.)

7560 (NVO-269-17) AMCHITKA RADIOBIOLOGICAL PROGRAM. Progress Report, May 1971-February 1972. Held, E. E. (Washington Univ., Seattle. Lab. of Radiation Ecology). Oct 1972. Contract AT(26-1)-269. 56p. Dep. NTIS.

Biological and environmental samples were collected periodically at Amchitka from September 1970 to November 1971, before the Cannikin test, and in November and December 1971 and in February 1972 after the Cannikin test. Gamma-emitting radionuclides in the samples were from worldwide fallout or were naturally occurring; none were of Amchitka origin except tritium, previously reported from ponds and test holes near the surface ground zero (SGZ) of the Long Shot nuclear detonation. The peak in fallout radionuclide concentrations in air filters, marine algae, and freshwater plants occurred in the spring of 1971. Iron-55 concentrations in Amchitka fish and canned salmon from the 1971 Bristol Bay pack were within the range of values reported from other parts of the Northern Hemisphere. In situ gamma-spectrum measurements in Amchitka's coastal waters were made before the Cannikin test and on D + 1. Only naturally occurring ^{40}K was detected by this method. The limits of detection for all measurements and analyses were far below the radioactivity concentration guide (RCG) values. It is concluded that there was no release of radioactivity as a result of the Cannikin test. (auth)

7561 (ORNL-EIS-72-21) ENVIRONMENTAL ASPECTS OF PLUTONIUM: A SELECTED, ANNOTATED BIBLIOGRAPHY. (Oak Ridge National Lab., Tenn.). Sep 1972. 392p. Dep. NTIS.

785 references to reports, journals, books, and conference proceedings on observations and measurement methods either on or applicable to Pu in the environment are given. The subjects of central concern were the movement of Pu through the environment, particularly that of the Nevada Test Site, with emphasis on its availability to man. Related material, such as biological effects of Pu, interaction of Pu with various ecosystems, and dispersion of fallout from nuclear explosions are also included. (P.C.H.)

7562 (PNE-WW-23) ENVIRONMENTAL MONITORING REPORT: PERIOD COVERING MAY 1, 1972-JULY 31, 1972. (Eberline Instrument Corp., Santa Fe, N. Mex. Dept. of Nuclear Sciences). 1972. 22p. Dep. NTIS.

For El Paso Natural Gas Co., Tex.

Beta radioactivity in air particulates ranged from 0.1 to 0.4 pCi/m^3. These results were consistent with those expected for the period, but were lower than those measured in March 1972 by the WERL Air Surveillance Network. The higher March values were attributed to a nuclear explosion in the atmosphere set off by the Peoples Republic of China on March 18, 1972. Most of the radioactivity during the May to July period was identified as CePr-144, RuRh-106, and ZrNb-95 from worldwide fallout. TLD data showed an average radiation background of 2.9 mrem/week. These results were consistent with previous levels and with background levels reported by the National Committee for Radiation Protection. Gross beta in surface, municipal, and well water ranged from less than 2 pCi/l to 14.3 pCi/l. The tritium concentration was less than 1 pC/ml in all of these samples. Gross beta in precipitation was 3.8 ± 0.2 nCi/m^2 during the period. The concentration of tritium was less than 1 pCi/ml in the precipitation. The concentration of Sr-90 in milk ranged from 7.2 to 14.7 pCi/l. Natural K-40 was in the 1200 to 1400 pCi/l range. Tritium concentration was less than 1 pCi/ml. (auth)

7563 NATURAL RADIOACTIVE DECAY SERIES ELEMENTS IN THE OCEANS AND SEDIMENTS. Thomson, J. (Yale Univ., New Haven); Walton, A. Proc. Roy. Soc. Edinburgh, Sect. B; 72: No. 15, 167-82(1971).

A literature review is presented of studies on radioisotopes in oceans and sediments. Studies of radium in oceans and sediments are reviewed with regard to the origin of high radium concentrations in sediments and the migration of radium in sediments. Studies on thorium and protactinium in oceans and sediments are discussed under the following headings: analytical advances; direct measurements of uranium, thorium, and protactinium isotopes; thorium isotope ratio ($^{230}Th/^{232}Th$) approach; thorium/protactinium ($^{230}Th/^{231}Pa$) approach; uranium isotope ratio ($^{234}U/^{238}U$) deviation; leaching versus solution of sediments; and comparisons of age determination methods. (H.L.W.)

Atmosphere

Refer also to abstracts 7801 and 7802.

7564 (BNL-17291) FINAL REPORT ON AN INTERAGENCY AGREEMENT BETWEEN U. S. ATOMIC ENERGY COMMISSION AND THE ENVIRONMENTAL PROTECTION AGENCY. Cowan, F. P.; Kuehner, A. V.; Phillips, L. F. (Brookhaven National Lab., Upton, N. Y.). 2 Oct 1972. 28p. Dep. NTIS.

This interagency agreement covered measurements in aircraft with the Brookhaven National Laboratory dose equivalent meter, said measurements being an extension of work previously sponsored by the Federal Aviation Agency (FAA) under interagency agreement FA-SS-71-7. Since the additional FAA flights originally planned for the fall of 1971 did not occur, and since this present interagency agreement was not finalized until February 25, 1972, measurements were made at ordinary jet altitudes for four values of geomagnetic latitude on flights in Air Force planes arranged for by Environmental Protection Agency (EPA). Measurements of dose equivalent on the four flights were made using the Baum dose equivalent meters previously fabricated and used in Alaska under the FAA-AEC interagency agreement. (auth)

7565 (BNL-17303) SAMPLING AND ANALYSIS OF RADIOACTIVE SUBSTANCES IN THE ATMOSPHERE. Hull, A. P. (Brookhaven National Lab., Upton, N. Y.). 1 Nov 1972. 14p. Dep. NTIS.

The Radioactive Substances Subcommittee of the Intersociety Committee on Methods for Air Sampling and Analysis (ISC) has formulated and published tentative methods for the sampling and analysis of radioactive substances. These include most of the nuclides or classes of nuclides commonly encountered in the environment. A description is presented of the sampling and analysis methods for the following: ^{210}Pb; ^{222}Rm; gross α; gross β; ^{131}I; ^{89}Sr; ^{90}Sr; ^{238}Pu; ^{239}Pu; and tritium. Methods for atmospheric sampling and analysis of ^{85}Kr, ^{14}C, and ^{129}I are currently under consideration by the subcommittee. (E.R.B.)

7566 (NERC-LV-539-12) COMPARISON OF FREEZE-OUT AND ADSORPTION TECHNIQUES FOR COLLECTION OF ATMOSPHERIC TRITIUM AS HTO. Fort, C. W.; Andrews, V. E.; Goldman, Aaron (National Environmental Research Center, Las Vegas, Nev. (USA)). Nov 1972. Contract AT(26-1)-539. 30p. Dep. NTIS.

A field study was conducted to compare the atmospheric concentrations of tritium as HTO determined from a passive freeze-out moisture collector and an air sampler using an adsorbent column of molecular sieve. Effluent from production test flaring of the Project Rulison experimental gas well produced by a nuclear detonation was used as an environmental source of atmospheric tritium. Also studied was the comparability of absolute humidity determinations based on two types of psychrometric measurements and water recovered from a known volume of air by the molecular sieve. From statistical analysis it was concluded that there was no significant difference between tritium measurements or humidity determinations as long as reasonable care was exercised in operating the samplers or making psychrometric measurements. (auth)

7567 (PNE-WW-22) ENVIRONMENTAL MONITORING REPORT: PERIOD COVERING FEBRUARY 1, 1972 THRU APRIL 30, 1972. (Eberline Instrument Corp., Santa Fe, N. Mex. Dept. of Nuclear Sciences). 1972. 22p. Dep. NTIS.

For El Paso Natural Gas Co., Tex.

Results of environmental monitoring at the site of Wagon Wheel Project, Pinedale, Wyoming, for the production of natural gas by the stimulation of wells by underground nuclear explosions are reported for the first quarter of 1972. Beta radioactivity in air particulate samples ranged from 0.05 to 0.66 pCi/m^3. The higher values in April are indicative of typical seasonal trends. Results are consistent with values reported by the Environmental Protection Agency (EPA) Air Surveillance Network. TLD data showed an average radiation background of 2.8 millirem per week. These results are consistent with previous levels and with background levels reported by the National Committee for Radiation Protection (NCRP Report No. 39). Milk, municipal and well water, and urine were analyzed as before and showed expected ranges. Surface waters for February and March were high in beta activity due to fallout from a Chinese nuclear test. There was insufficient moisture present to analyze either the air sample or the precipitation sample. Animal, soil, vegetation, and aquatic samples were not collected this quarter. Soil samples will be collected in June and the remaining samples are scheduled for collection in the fall. (auth)

7568 INDUCED AIRBORNE RADIOACTIVITY AT PRAGUE-BULOVKA DURING THE YEAR 1971. Behounek, Frantisek; Matouskova, Jirina (Lab. of Radiological Dosimetry, Prague). Jad. Energ.; 18: No. 12, 398-401(Dec 1972).

The annual results found at Prague-Bulovka for the ground-level air induced radioactivity are compared to those from some other European stations for the gross beta radioactivity as well as for the gamma spectrometry. For the first time a Ge(Li) de-

tector was used in the gamma spectrometry and a better resolution achieved than with the NaI(Tl) scintillation crystal applied in previous work. Short-lived nuclides produced by recent tests of nuclear weapons are always present even if no direct connection between the activity of the ground level air and the date of the burst may be established with certitude. The usual summer maximum of gross beta activity occurs in Prague at the same time as at other observatories chosen for comparison. (auth)

7569 RADIOACTIVITY OF THE ATMOSPHERE AND CERTAIN FOOD PRODUCTS IN MOSCOW IN 1968 TO 1970. Zykova, A. S.; Telushkina, E. L.; Efremova, G. P.; (and others). Gig. Sanit.; No. 9, 38-42(Sep 1972). (In Russian).

The amounts and the dynamics of radioactive fallout and the concentrations of radioactive aerosols in the air at ground level were measured in Moscow from 1968 to 1970. Definitely on the increase in aerosol form were the isotopes $^{95}Zr \rightarrow {}^{95}Nb$, ^{103}Ru, and $^{106}Ru \rightarrow {}^{106}Rh$. The Ce and Sr radioisotopes increased only very slightly. The ^{90}Sr and ^{137}Cs contents in milk, potatoes, and cabbage from three regions near Moscow were tabulated for the years 1967 through 1970. A tendency of the ^{137}Cs content to increase over this period was noted and to a lesser extent, ^{90}Sr. (K.S.W.)

Soil

7570 (ANL-Trans-931) PRACTICAL UTILIZATION OF THE DISTRIBUTION COEFFICIENT FOR THE MEASUREMENT OF THE RADIOACTIVE CONTAMINATION OF MINERALS IN ROCKS, SOIL, AND SUBTERRANEAN WATER. Rancon, Daniel. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from report CEA-R-4274. 33p. Dep. NTIS.

The uptake of radioisotopes by soils or the diffusion in subterranean waters is often estimated with the distribution coefficient (Kd) of the radioisotope between the solution and the solid. In practice, many precautions have to be taken so that the Kd measurements will be representative of natural media. As a matter of fact, the Kd depends on the chemical form of the radioisotope, on the nature and composition of the solution and on the nature of the minerals constituting the rock. But it is also necessary to take into account the texture and the grain size of the material. The Kd does not represent a physicochemical characteristic when applied to consolidated rocks of very low permeability, since it is dependent upon specific surfaces according to a determined law. Accordingly, an alternative concept has been defined for uptake by rocks of this nature, i.e., the surface distribution coefficient or Kd (S). Experience has shown that the value of Kd (S) was constant and characteristic of a consolidated rock and a radioisotope for a specific contact time. (auth)

Water

7571 HYGIENIC STANDARDIZATION OF THE PERMISSIBLE CONTENTS OF URANIUM IN THE DRINKING WATER. Novikov, Yu. V. (Moscow Scientific Research Inst. of Sanitation). Gig. Sanit.; No. 9, 13-17(Sep 1972). (In Russian).

The annual average permissible concentration (APC) of uranium in drinking water for individual persons among the population was determined to be 1.8 mg/l. (auth)

7572 ^{14}C CONCENTRATIONS IN THE SOUTHERN OCEANS. Fairhall, A. W.; Bradford, P.; Young, A. W. (Univ. of Washington, Seattle). Contract AT(45-1)-2225. Antarct. J. U. S.; 7: No. 5, 208-9(1972).

Radiocarbon concentrations in seawater were measured by counting the ^{14}C radioactivity in the inorganic carbon extracted from samples of seawater and aliquots of seawater were analyzed by gas chromatography for total carbon dioxide. The combination of the two measurements allowed the absolute number of ^{14}C atoms per liter to be determined. Data are presented for a number of stations on USNS Eltanin cruises during 1969 and 1970. The influence of nuclear weapons testing on the results is discussed. (H.L.W.)

7573 SOVIET INVESTIGATIONS OF NATURAL RADIONUCLIDES IN MARINE AND OCEAN SEDIMENTS. Baturin, G. N.; Ilyina, T. D.; Popov, N. I. (Inst. of Oceanology, Moscow). Proc. Roy. Soc. Edinburgh, Sect. B; 72: No. 16, 183-91(1971).

Investigations of the radioactivity of marine and ocean sediments, begun in the USSR in 1944, helped to reveal the basic traits of marine geochemistry of natural radioelements. Among them U is the most mobile and ^{232}Th the most inert in the marine sedimentary cycle. Considerable work has been done in developing the absolute dating methods based on the use of Th and U isotopes. It seems that the $^{230}Th-{}^{231}Pa$ method is the most reliable for oceanic conditions. The determinations of the total radioactivity and the analysis of the gamma spectrum of marine sediments made in situ and in the laboratory are largely used for revealing tectonic structures as well as the facies composition and content of certain radioelements in sediments. (auth)

Ecosystems and Food Cycles

Refer also to abstracts 7793, 7794, 7803, and 7812.

7574 (SRO-642-3) AN EVALUATION OF THE FACTORS INVOLVED IN BIOACCUMULATION OF γ-EMITTING RADIONUCLIDES IN WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS). Fourth Technical Progress Report, February 1, 1972-January 31, 1973. Jenkins, J. H. (Georgia Univ., Athens. School of Forest Resources). 1 Nov 1972. Contract AT(38-1)-642. 87p. Dep. NTIS.

A paper "Resource Specialist Report on SRP Land Planning" is included in this report.

Over 200 white-tailed deer were monitored for gamma-emitting radionuclides this past year (Oct. 1971 to Oct. 1972). Approximately one-half of these samples were collected in Georgia from four different physiographic regions. The Lower Coastal Plain continues to yield amazingly high values of ^{137}Cs, the highest values now being recorded in North America. Deer muscle from the Lower Coastal Plain in Georgia averaged 21,169 pCi/Kg in ^{137}Cs with a high of 45,525 pCi/Kg recorded in the month of December. Specimens from the Piedmont averaged 3,056 pCi/Kg, while the Upper Coastal Plain and Southern Appalachian deer averaged 952 pCi/Kg and 8,802 pCi/Kg. There has been a small decline since 1969 in ^{137}Cs in the Lower Coastal Plain deer; however, values for the other regions of Georgia remain about the same over the past four years. Strontium-90 levels were 85% higher in Lower Coastal Plain deer than in the previous year. Lower Coastal Plain deer averaged 57,011 pCi/Kg of wet bone with one sample reaching a high of 91,416 pCi/Kg. A fertilization study was conducted on two areas; one control plot and one fertilized plot. The object of this study was to determine if fertilization with a potassium fertilizer retards ^{137}Cs uptake and accumulation by plants. The vegetation studied was typical of the native vegetation of the Lower Coastal Plain region of the southeastern United States. This region has a long growing season and the vegetation is persistent-leaved and therefore able to concentrate ^{137}Cs over a period of several seasons. There was little difference between ^{137}Cs levels in vegetation of the two plots a year after fertilization. We have attached a condensation of a thesis on the vegetation, soils, and mineral interactions in radionuclide transfer and bioaccumulation that we consider to be the best explanation of the unique interactions resulting in the strange biomagnification phenomena of the Lower Coastal Plain wildlife, deer in particular. The dominant vegetation contained peak levels of ^{137}Cs during the summer while the deer from the same area had highest burdens during late fall and winter. We have collected mushrooms from the Waycross area that have contained 150,600 pCi/Kg of ^{137}Cs. Mushrooms are very abundant during the time of high ^{137}Cs burdens in deer and it is quite probable that mushrooms along with several other high level browse plants account for the elevated burdens in deer during the fall and winter. The annual furbearer census now in its eighteenth year was carried out entirely with large humane box-traps and the catch was back up from the past year, but the composition of the species involved has changed somewhat in the past two years. We have included a report on the Savannah River Project wildlife populations as a part of the overall evaluation study of the role of the U. S. Forest Service on the SRP lands. (auth)

7575 MIGRATION OF URANIUM FROM THE ENVIRONMENT INTO A HUMAN BEING. Berdnikova, A. V. (Donetsk Medical Inst., USSR). Faktory Vnesh. Sredy Ikh Znachenie Zdorov'ya Naseleniya; No. 2, 135-7(1970). (In Russian).

A total of 250 various samples of water, food products, and human organs were investigated, and the results were treated statistically. The water U content was $9.5 \times 10^{-7} \pm 3.2 \times 10^{-7}$; meat $6.1 \times 10^{-10} \pm 1.8 \times 10^{-10}$; milk $1.3 \times 10^{-10} \pm 0.85 \times 10^{-10}$; eggs $9.0 \times 10^{-10} \pm 3.6 \times 10^{-10}$; and vegetative products $5.1 \times 10^{-10} \pm 0.9 \times 10^{-10}$ (g/g). It appears that U has a definite physiological function. U was always present in the urine of people who resided permanently in the investigated region (1.05×10^{-6} g/day). The greater amts. of U accumulated in the bones, kidneys, internal secretion glands, and organs related to the reproductive activities, and was directly proportional to the amt. in the environment. (Euratom)

Radiometric Techniques

Refer also to abstracts 7573 and 7629.

7576 (IAEA-R-759-F) STUDY OF CROP WATER REQUIREMENTS IN NORTHERN SUDAN, USING RADIOISOTOPE TECHNIQUES. Final Report, February 1, 1970–December 31, 1971. El-Nadi, A. H.; Osman, A. M. (International Atomic Energy Agency, Vienna (Austria)). Dec 1971. 25p. INIS.

Studies were made on the efficiency of water use by a maize crop grown under different water treatments under the arid tropical climate of Northern Sudan. The total amount of water applied to the four treatments of the experiment were 630, 490, 410, and 352 mm, respectively. Four replicates were used. The experimental plots were 4 × 4 m, separated by corrugated iron sheets down to the depth of 90 cm and the experimental site was surrounded by adequate guard area. The soil moisture content was measured every 10 cm down to the depth of 130 cm with the aid of a neutron moisture meter just before and two days after irrigation. Occasionally soil samples were taken down to the depth of 90 cm, and the moisture content was gravimetrically determined. The results indicated that the air dry weight of shoots, the number of cobs, grain yield, litre weight, and the one-thousand-grain weight increased with the increase of total amount of water applied. Also, the results showed that the highest water use efficiency (478 g grain per m^3 of water) was achieved for the treatment to which the greatest amount of water was applied (630 mm). The drought conditions induced an earliness in maturity which amounted to a difference of 13 days between extreme conditions. This effect was accompanied by a great yield reduction. The relatively high evaporation rates (10 to 15 mm per day) recorded from the Class A pan were due to the prevailing high temperature, low relative humidity (50 to 20%), and to the high degree of insolation. The Penman estimate of evaporation during the growth season was about 30% less than that measured with the class A pan. (INIS)

7577 RADIOGENIC HEAT FLOW IN THE TERRITORY OF THE UKRAINE. Gordienko, V. V. (Inst. of Geophysics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 7, 622-5 (Jul 1972). (In Ukrainian).

Radiogenic heat flow along the DSS profiles in the Ukraine was calculated from the data on radioactive decay in various rocks and crustal structure. The results are compared with observed heat flow values. A fairly good coincidence with the observed data was obtained for the platform territory. (auth)

7578 LAVERTON–EDJUDINA AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY, WESTERN AUSTRALIA 1969. Tipper, D. B.; Gerdes, R. Aust., Bur. Miner. Resour., Geol. Geophys., Bull.; No. 118, 1-36(1971).

An airborne magnetic and radiometric survey of the Laverton and Edjudina 1:250,000 map areas was flown in 1966 to assist the systematic regional geological mapping of the Western Australian Precambrian Shield, and the search for metals. Virtually the entire magnetic pattern is attributed to differences in magnetic properties between rock units at or near ground level. Geological strikes and the boundaries of major rock units have been interpreted by delineating magnetic trends, by subdividing the area into zones of specified magnetic character, and by assessing the geological significance of these zones by reference to mapped geology. According to the interpretation, the area comprises vast heterogeneous acidic igneous masses, with ill-defined more basic regions, which enclose elongated outcrops of interbedded lava and sediment sequences. Both this regional interpretation and a more detailed analysis show good agreement with mapped geology. Areas where geological and magnetic evidence conflict are discussed in some detail. Sixteen fold axes, one cross-fold axis, twelve major dykes (one remanently magnetized), and fourteen faults have been delineated. Ultrabasic intrusions, which may have some economic importance, cannot be resolved with absolute certainty from the magnetic pattern; however, eleven areas which have a high probability of containing these rocks are recommended for ground investigation. The radiometric data reveal many high radiometric anomalies which are mainly correlated with granite outcrops. Some granite masses have a greater radioactive content than others. Eighty-three radiometric anomalies satisfying the point-source criteria were detected and, of these, fifty-one are recommended for ground investigation. (auth)

Site Surveys

Refer also to abstracts 7543–7547.

Thermal Effluents

Refer also to abstracts 9071, 9078, 9082, 9098, 9100, 9104, 9108, and 9125.

7579 PROBLEMS OF THERMAL POLLUTION OF FLOWING WATER BY POWER STATIONS. Jansen, P.; Stehfest, H. (Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech.; 44: No. 20, 1141-5(Oct 1972). (In German).

The various parameters determining the output of power plants cooled by fresh water are considered for the Rhine as example. They are: the maximum permissible increase in temperature over the natural state; the permissible maximum temperature; the required performance of the power plants; the efficiency of the power plants; and the meteorological and hydrological data of importance in the natural cooling of the river. It is apparent that the waste heat problem with fresh-water cooling will be solvable for only a very limited period unless the ecology of the river is to be completely upset. Considerable changes result from relatively slight warming owing to the synergism between warming and biological pollution. In conclusion, the necessity of ecological and technological analyses on changing over to other cooling methods is pointed out. (auth)

7580 RIVER ECOLOGY AND MAN. Proceedings of an International Symposium Held at Amherst, Massachusetts, June 20–23, 1971. Oglesby, R. T.; Carlson, C. A.; McCann, J. A. (eds.). Environmental Sciences, An Interdisciplinary Monograph Series. New York; Academic Press, Inc. (1972). 479p. $11.50. (CONF-710610).

A separate abstract was prepared for three of the nineteen papers in the book. The remaining papers discuss topics in the following general areas: what is a river; uses of a river–past and present; effects of river uses; and rationalization of multiple uses. (E.R.B.)

For abstracts of individual papers see: 7557, 7581, and 7582.

7581 MAN'S IMPACT ON THE COLUMBIA RIVER. Trefethen, P. (National Marine Fisheries Service, Seattle). pp 77-98 of River Ecology and Man. /Oglesby, R. T. (ed.). New York; Academic Press, Inc. (1972).

From International symposium on river ecology and the impact of man; Amherst, Mass. (20 Jun 1971). See CONF-710610.

Commercial and industrial expansion has had a large impact on the Columbia River. As a part of this impact, the ecology of the Pacific salmon (Oncorhynchus spp.) and the steelhead trout (Salmo gairdneri) has been affected. A review is presented of the changes in the environment that threaten salmonids and activities directed toward alleviating conditions critical to their survival during the freshwater phases of their life cycle. (E.R.B.)

7582 COMPARATIVE ASSESSMENT OF THERMAL EFFECTS IN SOME BRITISH AND NORTH AMERICAN RIVERS. Langford, T. E. (Central Electricity Generating Board, Nottingham, Eng.). pp 319-51 of River Ecology and Man. /Oglesby, R. T. (ed.). New York; Academic Press, Inc. (1972).

From International symposium on river ecology and the impact of man; Amherst, Mass. (20 Jun 1971). See CONF-710610.

The most relevant data on the effects of heated discharges in British and United States rivers are summarized. The following topics are included in the discussion: use and availability of cooling water; effects of power stations on river temperature; chemical effects of power station discharges; biological effects of cooling water discharges; future water use developments; criteria for future discharges; and future research. (E.R.B.)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstract 9005.

7583 (AD–741796) NEUTRON DETECTION EFFICIENCY OF AN ORGANIC SCINTILLATOR. Werkheiser, A. H.; Genser, J. R.; Polk, R. G.; Miller, T. G. (Army Missile Command, Redstone Arsenal, Ala.). Dec 1971. 80p. (RR-TR-71-16). NTIS.

The detection efficiency of the liquid scintillator NE-213 has been measured directly at 14.5 MeV neutron energy by the associated particle technique using the recoil alpha particles from the T(d,n)He-4 reaction. Below 14.5 MeV the detection efficiency was determined by n,p scattering. Comparisons were made between these measured efficiencies and calculated efficiencies. The calculated efficiencies included both analytic and Monte Carlo type calculations. (auth)

7584 (BMBW-FBK–72-14) DEVELOPMENT OF METHODS AND INSTRUMENTS FOR LONG-TERM RADON MONITORING IN MINES. Haider, B.; Jacobi, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Aug 1972. 88p. (In German). Dep. NTIS (U. S. Sales Only).

To estimate the radon exposure of miners, suitable methods and instruments for the long-term, integral measurement of α-activity in the air of radon-containing mines have been developed. The filter method for the detection of radon-daughters have been proven to be the most suitable method for this purpose. Prototypes of portable, battery-operated,low-power radon monitors were developed, which allow with one battery-loading a sampling time of 8 to 14 days. In the direct indicating instruments, Si-semiconductors are used for the measurement of α filter activity. In addition the applicability of track etch foils as integrating α-detectors is studied. The lower detection limit of these instruments is 0.001 WL. The results of test measurements in fluorspar mines are described. (auth)

7585 (BNL–17409) CONVERSION OF VICTOREEN MODEL 6 CDV 700 GM INSTRUMENTS FOR USE WITH SCINTILLATION OR BF_3 PROBES. Pollock, B. S.; Hagelberg, Edwin (Brookhaven National Lab., Upton, N. Y.). 1 Nov 1972. 4p. Dep. NTIS.

Modifications are described to convert the Victoreen Model 6 of the CDV 700 series instruments so that they will accept an alpha or thermal neutron detector and still retain the original GM beta gamma capability. (TSS)

7586 (KFK–1623) INVESTIGATION OF THE ENERGY DEPENDENCE OF W (LOSS OF ENERGY PER ION PAIR) FOR PROTONS IN HYDROGEN, METHANE, AND H_2–CH_4-MIXTURES IN VIEW OF NEUTRON SPECTRAL MEASUREMENTS WITH RECOIL PROTON PROPORTIONAL COUNTER TUBES BELOW 25 keV. Breitung, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jun 1972. 58p. (In German). Dep. NTIS (U. S. Sales Only).

A method in case for the destination of neutron spectra is the measurement with proton recoil proportional counters. A necessary prerequisite to this is the knowledge of the specific energy loss w of protons in the counting gas. Since only little has been known so far about w in the energy region below 25 keV, the specific energy loss for protons was measured in the commonly used counting gases hydrogen, methane and H_2-CH_4-mixtures below 25 keV. A comparison with existing publications shows that two energy regions must be distinguished with respect to the accuracy with which w could be measured. Below 10 keV the results of the different authors deviate from each other so much that the accuracy of 10% envisaged in the flux measurement is not guaranteed. For energies greater than 10 keV it can be assumed, on the basis of the agreement between these measurements and the work published so far that w is known with sufficient accuracy in the counting gases mentioned to determine the neutron flux by the proton recoil method with an error of less than 10%. (auth)

7587 (LA–5073) USING MULTIWIRE PROPORTIONAL CHAMBER DECODERS. Martin, E. R.; Jones, D. F. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 13p. Dep. NTIS.

MP-Division has now designed and constructed the decoder units for processing the signals from up to 8K active wires in a multiwire proportional chamber system, reducing these wire hits to binary information, and storing these data in an output buffer for computer consumption. The operation of these units is described from the user point of view, and how one might interface these units to various minicomputer systems is briefly discussed. (auth)

7588 (LA–5085) USING THE CA3054 MWPC AMPLIFIER. Jones, D. F.; Martin, E. R. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 4p. Dep. NTIS.

MP-Division has designed a front-end amplifier, discriminator and driver for multiwire proportional chamber signals, of which 4K have already been built for off-chamber use and another 4K are presently under construction. The circuit waveform analysis and the amplifier tune-up and troubleshooting procedure are described. (auth)

7589 (LBL–1062) PERFORMANCE CHARACTERISTICS OF ELECTRON RING ACCELERATORS. Moehl, D.; Laslett, L. J.; Sessler, A. M. (California Univ., Berkeley. Lawrence Berkeley Lab.). 1 Sep 1972. Contract W-7405-eng-48. 25p. (CONF-720952–1). Dep. NTIS.

From Symposium on collective methods of acceleration; Dubna, USSR (27 Sep 1972).

On the basis of the present understanding of the physical phenomena involved in an electron ring accelerator (ERA), a theoretical study is made of the performance which might be expected for an ERA. Rigorous upper bounds are obtained on the rate of energy gain, from which it is shown that, in order to prevent azimuthal instability, parameters must be selected such that (for reasonable fields, injector properties, etc., but with no safety factors) the proton energy gain is less than 80 MeV/m. Numerical examples and approximate formulas are given for the properties of rings satisfying the stability conditions for both azimuthal oscillations and ion-electron oscillations. It is found that for reasonable fields and injector properties, but without safety factors, the useable proton energy gain is less than 45 MeV/m. (auth)

7590 EVALUATION OF THE PERFORMANCE OF A MULTISLIT COLLIMATOR SUITABLE FOR A 75mm CRYSTAL. Bok, B. (Paris Univ., Orsay, France); Di Paola, R. J. Biol. Med. Nucl.; 7: No. 28, 14-20(1972). (In French).

A focusing collimator with three slits was built specifically for profile scanning. Its performances were studied using a digital scintigraphy system where each line of the resulting scan corresponded to the spread function at one particular depth. Since the processing routines in this system can be easily modified, the data processing and visualization are simple to use. Point sensitivity is excellent (4500 imp./μCi); resolution also appears to be satisfactory. The variation of sensitivity with depth remains within acceptable limits (25% at 10 cm). The digital acquisition of profiles also permits the data processing of such scans. (France)

7591 DETECTION CIRCUIT WITH Ge(Li) DETECTORS COOLED WITH A THERMOELECTRIC BATTERY. Dneprovskii, I. S.; Vakhonina, A. P.; Popeko, L. A.; Samoilov, P. S.; Shishkina, G. A. Yadern. Priborostr.; No. 13, 22-37(1970). (In Russian).

The possibility of the use, for γ spectrometry, of Ge(Li) detectors, cooled with a tetracascade thermoelectric battery instead of liquid nitrogen, is discussed. The proposed technical solution was proved by the experimentally determined temperature dependence of the electrophysical and spectrometric characteristics of the detector with sensitive volume from 0.5 to 5 cm^3. The resolving capacity of the detectors and its components were studied in the temperature range from 77 to 211°K. It was shown that its value for individual detectors is better by one order of magnitude than the resolving capacity of scintillation detectors of average dimensions even during cooling only to 180°K. The dependences of the temperature of the cooling of the thermobattery on the feed current, heat load, temperature of the water, outlet heat, and other characteristics are reported. The construction of the cryostat and the battery which forms the independent detection circuit is described. (tr-auth)

7592 SCINTILLATION PLASTIC DETECTOR WITH EXTENDED SURFACE FOR THE REGISTRATION OF THE SPECIFIC BETA ACTIVITY OF AQUEOUS MEDIUM. Arsaev, M. I.; Bachurin, A. V.; Vlasov, V. G.; (and others). Yadern. Priborostr.; No. 13, 14-21(1970). (In Russian).

The results of the development of a polystyrole-based scintillation plastic detector with extended surface are reported. The reason for the selection of the type and construction of the detector is given. The construction and the fabrication of the detector are described, and results of the experimental investigation of the basic parameters are reported. It is shown that the threshold sensitivity of the detector during registration of the specific activity of aqueous solutions of the isotopes $^{90}Sr + {}^{90}Y$ for 10 min

with basic error not exceeding ±35% is $q = 2.4 \times 10^{-10}$ curie/l without use of the shield and $q = 1 \times 10^{-10}$ curie/l with use of the lead shield with a 50-mm thick wall. (tr-auth)

7593 USE OF THE DOUBLE SANDWICH METHOD FOR INVESTIGATION OF THE EFFECTIVE TEMPERATURE OF NEUTRONS IN THE VOIDS OF GRAPHITE REACTORS. Mordovskaya, T. S.; Petrov, V. I. Yadern. Priborostr.; No. 13, 59-65 (1970). (In Russian).

A new detector for measurement of the temperature of thermal neutrons in the voids of the moderator is examined. The detector is a sandwich of detectors and absorbent filters, combined in the sequence: detector–filter–detector–filter–detector. The results obtained agree with the results obtained using ^{176}Lu–^{54}Mn detectors within the margin of error of the measurement. (tr-auth)

7594 DEVELOPMENT OF UNIFIED SYSTEMS OF RADIOMETERS FOR LIQUIDS. Isakov, L.M.; Matveev, V. V.; El'tsin, G. I. Yadern. Priborostr.; No. 15, 50-8(1971). (In Russian).

Questions on the systematic approach to the development of nuclear physical devices as illustrated by the development of a unified system of radiometers for liquids are examined. The principles of its construction are discussed, and a specific variant of the system with tentative intake parameters is described. (tr-auth)

7595 MEASUREMENT OF THE SENSITIVITY OF SILICON SEMICONDUCTOR DETECTORS FOR X RADIATION. Baldin, S. A.; Ioannesyants, L. M. Yadern. Priborostr.; No. 15, 40-3 (1971). (In Russian).

The different methods for the determination of the efficiency of semiconductor detectors of ionizing radiation are examined. The sensitivity and its dependence on the energy in the range from 6 to 60 keV were experimentally determined for silicon semiconductor detectors for x radiation with a resolution of 750 eV at 14 keV. The data obtained were used for measurement with the radioactive source ^{170}Tm of the conversion factor of a cascade emitter. (tr-auth)

7596 LINEAR SUMMATION CIRCUIT FOR SEMICONDUCTOR DETECTORS. Aloev, A. S.; Vartanov, N. A.; Stugarev, Yu. N. Yadern. Priborostr.; No. 15, 94-9(1971). (In Russian).

A transistorized linear summation device, designed for operation with semiconductor detectors is examined. A description is given of the principles of the operation of the installation and principal electrical circuits. The range of the summation circuit for pulse amplitudes and linearity of the summation circuit were determined with the use of a ^{22}Na source. It was shown that the selected circuit does not impair the energy resolution of the semiconductor Ge(Li) detector. (tr-auth)

7597 RECIPE FOR MAKING A THIN FILM DETECTOR. Muga, M. L.; Burnsed, D. J.; Steeger, W. E. (Univ. of Florida, Gainesville). Nucl. Instrum. Methods; 104: No. 3, 605-10(1972).

The thin film detector consists of a thin scintillator film placed perpendicular to the parallel faces of two opposing photomultiplier tubes and uniquely is capable of responding to the differential energy loss of transiting heavy ions (e.g., fission fragments). A step-by-step procedure for fabricating a thin film detector is presented. Testing routines are described and typical results are shown for comparing the relative performance of the finished product with regard to light and heavy ion energy loss response. (auth)

7598 Ge–Si ALLOY: A NEW TYPE OF NUCLEAR RADIATION DETECTOR. Alexander, P.; Shulman, H. (Teledyne Isotopes, Westwood, NJ). Nucl. Instrum. Methods; 104: No. 3, 597-604(1972).

Gamma ray and charged-particle detectors have been fabricated from lithium drifted single crystals of germanium–silicon alloy. Detector volumes of ≈ 1 cm^3 have been obtained using silicon-rich alloy crystals containing as much as 9 atomic percent germanium. Somewhat smaller detectors have been fabricated from germanium-rich crystals containing as much as 7 atomic percent silicon. The properties of these detectors have been investigated and discussed. The silicon-rich alloy crystals have a markedly higher photoelectric interaction efficiency than that characterizing ordinary silicon detectors. The germanium-rich alloy diodes possess a photoefficiency close to that of germanium and can be operated at significantly higher temperatures than germanium diodes. The results of radiation damage experiments on the silicon-rich alloy suggest that these detectors also possess a resistance to radiation damage greatly exceeding that of silicon. At this juncture it is not known whether the radiation hardness evidenced by the silicon-rich detectors also applies to the germanium-rich detectors. (auth)

7599 CALCULATED TOTAL EFFICIENCIES OF COAXIAL Ge(Li) DETECTORS WITH SMALL DISC SOURCES. Atwater, H. F. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 104: No. 3, 589-91(1972).

Total gamma-ray efficiencies of coaxial Ge(Li) detectors are calculated from 20 keV to 10 MeV for disc sources having radii varying from 10% to 90% of the radius of the p-type detector core. Detectors with radial depletion depths from 7 to 20 mm and volumes from 10 to 100 cm^3 are considered. Source to detector distances vary from 3 to 25 cm. (auth)

7600 TIMING SYSTEM FOR Ge(Li) DETECTORS. Akimov, Yu. K.; Andert, K.; Kalinin, A. I.; Ortlepp, H. G. (Joint Inst. for Nuclear Research., Moscow). Nucl. Instrum. Methods; 104: No. 3, 581-8(1972).

A timing system for coincidence and nuclear lifetime measurements with Ge(Li) detectors is described. The timing discriminator, based on the ARC-principle, is designed using integrated circuits. Uncompensated pulses from low energy events near the threshold of the timing discriminator are eliminated by a special internal coincidence circuit. Output pulses caused by noise, are excluded by duration discrimination. The detector signals are amplified by a preamplifier and fast amplifier with 2.5 and 3.5 ns risetimes, respectively. The time resolution has been obtained 15.6, 2.7 and 1.1 ns fwhm for energies 50, 511 and 1330 keV, respectively, by using a planar detector (1.9 cm^3) with a collection time of 40 ns. The differential peak shift in the range from 10 to 1330 keV was 1.2 ns. (auth)

7601 RESPONSE OF THE NBS P2 STANDARD IONIZATION CHAMBER IN INTENSE PULSED BEAMS. Baglin, J. E. E. (Ames Lab., Iowa); Bentz, E. J. Jr.; Carr, R. W.; Wu, C. P.; Schultz, H. L. Nucl. Instrum. Methods; 104: No. 3, 575-9 (1972).

Possible saturation effects in a National Bureau of Standards "P2" ionization chamber used in intense pulsed bremsstrahlung beams were investigated. At peak incident power levels up to 10 W/cm^2, no saturation was found within our 0.5% sensitivity. At 75 W/cm^2, a 4% effect is indicated. This is presumed to be the result of ion recombination in the air-filled chamber. Substitution of dry nitrogen in a sealed chamber is recommended. (auth)

7602 MONTE CARLO CALCULATION OF THE ANALYZING EFFICIENCY OF GAMMA-RAY CIRCULAR POLARIMETERS. Lipson, E. D.; Vanderleeden, J. C. (California Inst. of Tech., Pasadena). Nucl. Instrum. Methods; 104: No. 3, 525-30(1972).

The efficiency for analyzing circular polarization of gamma rays with a forward scattering Compton polarimeter has been calculated using Monte Carlo techniques and a density matrix formalism. Effects of multiple scattering and linear polarization have been included. Emphasis has been placed on integral detection methods, which lack energy resolution. It is shown that multiple scattering has a considerable influence on the intensity and polarization efficiency functions. (auth)

7603 GEOMETRICAL ASPECTS OF THE PERFORMANCE OF COSMIC RAY DETECTOR TELESCOPES IN NON-ISOTROPIC PARTICLE DISTRIBUTIONS. Sanderson, T. R.; Page, D. E. (European Space Research and Tech. Center, Noordwijk, Netherlands). Nucl. Instrum. Methods; 104: No. 3, 493-504(1972).

The performance of a cosmic ray detector telescope made from two circular discs is investigated. Results of calculations are presented on the following: 1) the geometric factor, 2) the angular response to a parallel beam of particles, and 3) the behavior in a non-isotropic particle distribution. The performance in a particle distribution takes into account the effective geometric factor, the path length distribution, and the effect of rotating the detector, with particular application to spinning rockets and satellites. Only rectilinear particle trajectories are considered. (auth)

7604 NEW $4\pi\beta$-MULTIWIRE PROPORTIONAL COUNTER FOR THE $4\pi\beta$–γ COINCIDENCE MEASUREMENTS. Plch, J.; Zderadicka, J.; Kokta, L. Radioisotopy; 13: No. 4, 687-746 (1972). (In Czech).

The error of the correction for the accidental coincidences contributes considerably to the total precision of $4\pi\beta$–γ coincidence counting. An essential decrease of the error can be achieved when the collection time of the primary electrons is reduced when a low multiwire proportional counter is used. The lowest height of the counter was estimated on the basis of calculation of the ion-number distribution for the ions collected on the cathode when hard beta-particles are detected. The height cannot be considerably reduced below 10 mm. A $4\pi\beta$-multiwire counter with the dimensions of $60 \times 60 \times 10$ mm of the counting volume in one half and with 11 wires of 20 μm was developed. The counter filled with technical-grade methane, exhibits good timing properties; the FWHM of the time spectrum was 18 nsec., and the full width was 100 nsec. when new fast integrated electronics was used. A fast RC-shaping produces a short dead time of about 2 μsec in the beta channel. A good counting plateau, of about 400 V with the slope less than 0.2%/100 V for ^{60}Co and less than 0.1%/100 V for ^{90}Sr, was measured even at high counting rates. (auth)

7605 DIGITAL STEREOSCINTIGRAPHY. Larsson, E. I. (Univ., Lund, Sweden). Acta Radiol., Suppl.; No. 313, 226-8 (1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

A simple and cheap method for stereoscintigraphy using conventional gamma camera equipment and digital storage facilities is described. (auth) (Sweden)

7606 NEW WHOLE BODY MONITORING LABORATORY. Skoeldborn, H.; Arvidsson, B.; Andersson, M. (Univ., Goteborg). Acta Radiol., Suppl.; No. 313, 233-41(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

The construction of a whole body monitoring laboratory at the Radiation Physics Department, Sahlgrenska Sjukhuset, University of Gothenburg, is described and preliminary data provided on technical specifications and calibration. (auth) (Sweden)

7607 MEASUREMENT OF THE RESOLUTION OF A GAMMA CAMERA SYSTEM. Svedberg, J. B. (Uppsala Univ.). Acta Radiol., Suppl.; No. 313, 242-6(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

A sub-group reporting to the ICRU presented a progress report on sensitivity and resolution in radioisotope scanning. The concepts developed should enable a direct comparison between theoretical and experimental results for moving detectors as well as for stationary devices. A theoretical investigation on the intrinsic resolution of an Anger gamma camera system revealed problems in adapting the concepts of resolution on stationary devices. Arguments for using point sources instead of line sources for determination of resolution are given. (auth) (Sweden)

7608 BETA AND GAMMA RADIOCHROMATOGRAPHY WITH SPARK CHAMBERS. Asard, P.-E. (Danderyds Sjukhus, Sweden). Acta Radiol., Suppl.; No. 313, 278-85(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

Experiments have been performed with two different mesh spark chambers to determine the suitability of this type of equipment for evaluation of radiochromatography and electrophoresis media. The resolution distances obtained for ^{3}H and ^{14}C are shown to be 0.5 mm or less. For the evaluation of gamma-emitting isotopes on the same media a new measurement technique is used. The resolution distances for ^{99m}Tc, ^{113m}In, ^{87m}Sr and ^{75}Se are shown to be 1 mm or less. (auth) (Sweden)

7609 INFLUENCE OF TEMPERATURE ON THE FINAL PARAMETERS OF DETECTORS, RADIOMETERS, AND SPECTROMETERS: A REVIEW OF THE PRESENT STATE OF THE PROBLEM. Silar, J. (Charles Univ., Prague). Radioisotopy; 13: No. 4, 747-847(1972). (In Czech).

Published results on the temperature dependence of scintillators and photomultiplier parameters are summarized. Based on the works of foreign authors and our own measurements on home-made products, conclusions are made on the temperature dependence of the most often used combinations of scintillators and photomultipliers and on the effect of the scintillation detector temperature dependence on the resulting parameters of spectrometers and radiometers. (auth)

7610 GAMMA-LUMINESCENCE FOR VISUAL CONTROL OF γ-SOURCES. Sauerwein, K. (Isotopen-Technik Dr. Sauerwein GmbH., Duesseldorf, Ger.). Atomwirt., Atomtech.; 17: No. 9-10, 530-1(1972). (In German).

Gamma radiation produces luminescence in solid as well as in liquid fluorescent materials, which can be exploited frequently in research and practice. Gamma radiation visualized by this method, for example, permits the positioning control of radiation sources, the measurement of beam intensity and dose distribution, the observation of the spatial radiation field, and general radiation protection. Indirect and direct visualization methods on this basis permit simpler and safer monitoring of radiation sources than any other presently available method. (tr-auth)

7611 OPTIMIZATION OF COLLIMATOR DESIGN FOR THE GAMMA SCINTILLATION CAMERA. Simmons, Guy Held. Cincinnati; Univ. of Cincinnati (1972). 114p. University Microfilms Order No. 72-23,592.

Thesis.

A new method for optimizing the design of multiaperture parallel-hole collimators for the gamma scintillation camera has been developed. The method takes into account the frequency spectrum of the object to be visualized as well as the energy of the radiation and the source-to-collimator distance. A statistical figure of merit equal to the product of the square of the modulation transfer function (MTF) of the detector-collimator combination and the collimator combination and the collimator plane source sensitivity is calculated for each spatial frequency in the object distribution. The Fourier spectrum of the object is computed and weighted to obtain an importance function for the frequency spectrum of the object. An objective function equal to the convolution of the statistical figure of merit and the weighted object Fourier spectrum is then computed. The optimization is performed using a sequential pattern search technique. Since the collimator MTF is the normalized Fourier transform of the collimator line spread function (LSF) in the detector plane, it is necessary to first compute the LSF for each collimator design considered. The LSF calculation is performed by means of a three dimensional ray tracing technique which computes the first collision transmission probabilities at a point in the detector plane from points along an infinitely long line source as the line source is moved across the face of the collimator. The detector MTF is computed from an experimentally measured detector LSF. The collimator penetration fraction for each design considered is also calculated as well as the sensitivity. The validity of the objective function is verified by means of an experimental performance index which was determined for existing commercial collimators. The relative values of the objective function for the existing collimators are checked against the values of the performance index. The results show that a positive correlation exists between the objective function and the performance index for the existing collimators. Also the commercial collimator designs are not optimal. Analysis of the detector and collimator MTF curves taken separately shows that much of the resolution capability of the commercial collimators is wasted because of the limitation imposed on the system by the detector resolution. It is therefore fruitless to design extremely high resolution collimators for use with the current detector system. Such practice results in decreased sensitivity with little corresponding increase in overall resolution. If, however, the detector resolution could be substantially improved, the results show that higher resolution collimators would increase the magnitude of the objective function by more than a factor of 4 over the optimum design determined for the present detector system. (auth) (Diss. Abstr. Int., B)

7612 DISTORTION PRODUCED BY PINHOLE COLLIMATORS. Cradduck, T. D. (Toronto General Hospital). J. Nucl. Med.; 13: No. 10, 778-9(Oct 1972).

The desirability of using a pinhole collimator at any time with a scintillation camera is questioned because point-source sensitivity varies inversely with the distance from the collimator and with $\sin^3\theta$ where θ is the angle the gamma ray makes with the crystal. Therefore the variation of uniformity across the crystal face is dependent on the collimator-to-source distance. A 75% variation at 2 in. from the collimator may be expected. (F.S.)

7613 GAMMA-RAY CAMERA USING A COAXIAL GERMANIUM DETECTOR. Strauss, M. G.; Sherman, I. S. (Argonne National Lab., Ill.). J. Nucl. Med.; 13: No. 10, 767-70(Oct 1972).

A gamma-ray camera using a coaxial Ge(Li) detector is designed to aid existing imaging devices in diagnostic procedures for imaging organs in vivo. The Ge(Li) detector, with an energy resolution about 25 times better than NaI(Tl) at 140 keV (^{99m}Tc), has a capacitance of ~5pF and requires only one high-performance preamplifier which allows it to be operated at cryogenic temperatures. The low-capacitance semiconductor and the low-noise preamplifier yield high-energy resolution. Gamma rays degraded by scattering in intervening tissue are rejected. (F.S.)

7614 EFFICIENCY DETERMINATION FOR SOME STANDARD TYPE Ge(Li) DETECTORS FOR GAMMA-RAYS IN THE ENERGY RANGE FROM 0.04 to 11 MeV. Seyfarth, H.; Hassan, A. M.; Hrastnik, B.; Goettel, P.; Delang, W. (Kernforschungsanlage Juelich, Ger.). Nucl. Instrum. Methods; 105: No. 2, 301-10 (1972).

Absolute full energy and double escape peak efficiencies of 38 and 31 cm^3 true coaxial and of 5.8 cm^3 planar Ge(Li) detectors have been determined for γ-rays from 0.04 to 11 MeV in an arrangement typical for γγ-coincidence experiments with thermal neutron capture γ-rays from an external target. The results are compared with theoretical predictions. Experimental results for the ratios of double escape, single escape and full energy peak areas against the γ-ray energy are presented. The measurements have been performed with the γ-rays from the radioactive sources ^{153}Gd, ^{169}Yb and ^{154}Eu and from the thermal neutron capture in ^{1}H, ^{12}C, ^{14}N, ^{39}K and ^{53}Cr. To check the efficiency curves obtained in the present experiment, the relative intensities of some γ-ray transitions in the reactions $^{39}K(n,\gamma)^{40}K$ and $^{45}Sc(n,\gamma)^{46}Sc$ are compared with the results of other authors. (auth)

7615 METHOD OF FISSION CHAMBER EFFICIENCY DETERMINATION USING UNCORRELATED NEUTRON BACK-

GROUND MEASUREMENT. Doolin, V.; Mozhaev, V. (Inst. of Physics and Energetics, Kaluga, USSR). Nucl. Instrum. Methods; 105: No. 2, 277-8(1972).

Use of the time dependence of the fast neutron background is made to determine the efficiency of the fission chamber with ^{252}Cf. Spontaneous fission neutrons have been detected by the stilbene scintillator with pulse-shape discrimination circuitry. The efficiency of the chamber has been determined by the n−f coincidence method as well. (auth)

7616 USE OF STICKING COEFFICIENTS FOR ON-LINE CHEMICAL ANALYSIS OF BEAMS OF SHORT LIVED NUCLIDES. Grover, J. R.; Lilienfeld, H. V. (Brookhaven National Lab., Upton, NY). Nucl. Instrum. Methods; 105: No. 2, 189-96(1972).

Construction and testing of a device capable of selectively detecting beam molecules labeled with short lived radioactive nuclides is described. The molecules to be detected adsorb in an exposed position on the specially prepared surface of a rotating drum and are then transported to a shielded position for counting. Species-dependent sticking coefficients are used to effect the chemical analysis. Detector surfaces of palladium, silver, antimony and tellurium chosen for analysis of mixtures of At and HAt gave overall detector efficiencies as large as 0.16 for ^{211}At atoms, and a discrimination factor of $\gtrsim 10^3$ for detection of 800-1200°C At in the presence of 25-300°C HAt. Time-stability and reproducibility are acceptable. The detector is small enough in comparison with its aperture to allow the use of arrays of ten or more, and it operates satisfactorily at pressures of 10^{-7} to 10^{-6} torr. The redundancy afforded by the availability of several suitable surfaces should serve as a valuable check on the reliability of measurements. New data on the sticking coefficients of hydrogen astatide molecules and astatine atoms on various metallic surfaces is reported. (auth)

7617 DETECTOR OF RADIATIONS EMITTED FROM RADIOACTIVE SUBSTANCES. Courrier, G. (to Compagnie Generale d'Electricite). French Patent 2,105,707. 28 Apr 1972. Filed 17 Sep 1970. (In French).

This radiation detector consists of a sensor and an emitting device whose input is connected to the sensor output. This emitting device emits visual information dependent upon the value of the signal produced by the sensor. The emitter consists of either a frequency voltage converter, comparators mounted in parallel, a digital analogue converter, or a threshold electronic device with outputs connected to a visual radiation source (particularly a laser diode). (France)

7618 IONIZATION CHAMBER FOR MEASURING X AND γ RADIATION. Dalmazzone, Jean (to Commissariat a l'Energie Atomique). French Patent 2,105,649. 28 Apr 1972. Filed 16 Sep 1972. (In French).

An ionization chamber for measuring x and γ radiations was developed. It consists of two spherical concentric electrodes in the form of a small hollow collector electrode positioned at the center of an external electrode connected to an h−t supply. The upper part of the chamber is provided with a support which holds the source to be measured. This source is isolated from the interior of the electrode by a thin window, which transmits x and γ radiation. Means are provided for regulating the atmosphere inside this external electrode. A rod connects the central electrode to the collector circuit. This rod, which radially traverses the h−t electrode, is electrically insulated from its walls. (France)

7619 DEVICE FOR ANALYZING A FAST NEUTRON FLUX. Donguy, R.; Graftieaux, J. (to Commissariat a l'Energie Atomique). French Patent 2,112,059. 16 Jun 1972. Filed 24 Aug 1970. (In French).

A method is proposed for analyzing and determining the mean energies of the two components (of very different energy) of a fast neutron flux. A thermal neutron detector is positioned behind a neutron moderator material (whose thickness can be varied) exposed to the flux. The neutron count rate is measured as a function of the thickness of the moderator material. The respective energies are determined from the two linear parts of the curve (plotted on semi-logarithmic axes) representing the count rate as a function of the moderator thickness. (France)

7620 MEASUREMENT OF X-RAY PEAK INTENSITIES WITH A LITHIUM DRIFTED SILICON DETECTOR BY INTEGRATION OVER A FIXED ENERGY RANGE. Reed, S. J. B.; Ware, N. G. (Australian National Univ., Canberra). J. Phys., E (London); 5: No. 11, 1112-14(Nov 1972).

A simple and convenient way of measuring x-ray peaks recorded by a Si(Li) detector is to sum the contents of an appropriate group of channels in the pulse height spectrum. However, such measurements are susceptible to errors due to shift and broadening of the pulse height distribution with increasing count rate. The results of calculations and measurements of these effects are given. It is concluded that errors can be kept below 1% provided certain conditions are observed. (auth)

7621 MEASUREMENT OF LOW LEVEL ENVIRONMENTAL TRITIUM SAMPLES. Barnes, J.; Carswell, D. J. (New South Wales Inst. of Tech., Broadway, Australia). J. Phys., E (London); 5: No. 11, 1089-90(Nov 1972).

Australian water samples have been shown to have a much lower tritium content than samples in the Northern hemisphere, and quantitative assay of their tritium content is correspondingly more difficult. A gas proportional counter using butane prepared from electrolytically enriched water samples is described. The counter, which has better counting characteristics for low level tritium assay than most others described in the literature, has been applied to assay of both surface and underground water samples. (auth)

7622 RESOLVING-TIME MEASUREMENTS OF G-M AND GAS-FLOW COUNTERS USING A TIME-TO-AMPLITUE CONVERTER. Nakamoto, Shunsuke (Chubu Inst. of Tech., Kasugai, Japan). Jap. J. Appl. Phys.; 11: No. 11, 1686-92(Nov 1972).

A slow time-to-amplitude converter is fabricated for the time interval measurements of self-quenching type GM and gas-flow counters. With this converter, the resolving times of counters are analyzed. The resolving time has the peak value at the beginning of the GM-threshold voltage and decreases at the higher supplied voltage. The approximate position of the ion sheath of the normal discharge at which the field strength of a counter recovers to the GM-threshold is also determined by comparing the resolving time with the calculated velocity of the ion sheath. The resolving time is proportional to the pulse amplitude at low supplied voltages and is nearly constant at higher voltages. These phenomena can be explained by the recovery curves of the field strength near the center wire. Another application of the converter is also suggested. (auth)

7623 LIQUID SCINTILLATOR METHODOLOGY. Ayad, M. (Imperial Coll. of Science and Tech., London). Lab. Pract.; 21: No. 10, 723-5; 728(Oct 1972).

A liquid scintillator system for the study of sonoluminescence and radioluminescence is discussed. A comparison was made of the effects of radioisotopes of different energies on the luminous flux output when the isotopes were added to the scintillator. The efficiencies of an α-source and β-sources when added to the liquid scintillator were investigated. An α-source from uranium 238 metal was prepared and standardized. Experiments were made to test the efficiencies of radioactivity and acoustic cavitation in producing luminosity. The relative powers required for unit luminosity were found to be of the order $1:10^{12}$ for radioluminescence and for sonoluminescence respectively. (auth)

7624 LIQUID NITROGEN LEVEL INDICATOR FOR USE WITH SEMICONDUCTOR RADIATION DETECTORS. Brown, L. D. (North East London Polytechnic). Lab. Pract.; 21: No. 10, 727-8(Oct 1972).

A description is given of an electrically operated sensing device for indicating the level of liquid nitrogen in a Dewar flask used for maintaining equipment at cryogenic temperatures. A thermistor is mounted inside a sealed tube in the flask in such a way as to minimize thermal shock and, by suitable thermal insulation, to reduce the liquid nitrogen loss from heat conduction down the device into the Dewar. Using a simple electric circuit the thermistor is wired directly in series with an a.c. mains operated relay; problems of drift are largely avoided. The room temperature resistance of the thermistor is very low, but at liquid nitrogen temperature it exceeds 10^8 ohms, so the liquid losses from electrical heating are negligible. When the liquid level drops below the thermistor sufficient heat is conducted down the leads to reduce its resistance to the point at which the relay is activated; this then operates an alarm or an automatic topping-up pump. It is stated that the device is reliable over a considerable period and overcomes disadvantages experienced with earlier designs. (UK)

7625 INCREASING NUCLEAR ENERGY AMOUNT REQUIRES SIMPLE RADIATION PROTECTION MEASURING DEVICES. Kosmowski, A.; Gebauer, H. Wasser, Luft Betr.; 16: No. 5, 133-5(1972). (In German).

The authors describe briefly: 1) Contamination monitor FHT 111E ('Contamat'), basic equipment with attached probe for neutron and gamma monitoring. 2) Permanently installed 'Contamat' for room radiation level monitoring in control areas. 3) Clothing contamination monitoring by means of the 'Contamat' probe. 4) Hand contamination control by means of the stationarily installed 'Contamat'. 5) Universal radiation protection metering channel FHT 700, digital electrons in 19' design for all radioactivity monitoring. (GF)

7626 NEUTRON COINCIDENCE DETECTOR. 4-LITERS (24 Sep 1971) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-2273).

14 drawings.

A Neutron Coincidence Counter, which is a compact instrument for assay of spontaneous fissioning isotopes, such as ^{238}Pu, ^{240}Pu, and ^{238}U is described. Neutrons from the spontaneous fission of these isotopes are detected with a polyethylene moderated neutron coincidence counter containing ^{3}He detectors. The observed coincidence counting rate is proportional to the quantity of these isotopes within the sample. This counter will accept samples up to approximate 1 gallon capacity.

Radiation Dosimeters

Refer also to abstracts 7564, 7752, and 7996.

7627 (BNL-16781) CERIC-CUPRIC SULFATE DOSIMETER. Bongirwar, D. R.; Weiss, J. (Brookhaven National Lab., Upton, N. Y.). [nd]. 18p. (CONF-721101-1). Dep. NTIS.

From International symposium on radiation preservation of food; Bombay, India (13 Nov 1972).

The ceric-cupric sulfate chemical dosimeter was investigated using cobalt-60 radiation over a dose range of 1 to 25 Megarads at the following concentrations: 50 mM Ce and 100 mM Cu, 25 mM Ce and 50 mM Cu, 25 mM Ce and 1 mM Cu, 25 and 50 mM Ce with no cupric ion. Initial testing and testing after storage of solution for three months indicate that the G-value does not change over the specified concentration ranges. Linearity studies indicate the following: 50 mM Ce with 100 mM Cu solutions are linear in response from 1 to 15 Megarads and 25 mM Ce + 50 mM Cu solutions are linear from 1 to 8 Megarads. Spectrophotometric analysis combined with dilution techniques was found to be a convenient and reliable method of analysis. The precision obtained with the system for reproducible results and measurements approached that of the Fricke dosimeter. (auth)

7628 (COO-3522-1) BIOLOGICAL AND CLINICAL DOSIMETRY. Annual Progress Report, July 1, 1971-June 30, 1972. Laughlin, John S. (Sloan-Kettering Inst. for Cancer Research, New York). 1972. Contract AT(11-1)-3522. 56p. Dep. NTIS.

Detailed studies of three cyclotron-produced ^{9}Be (x,n) neutron spectra were conducted. These include: 1) The measurement of on-axis depth dose distributions at a number of SSD's. Data were analyzed to allow dose rates to be calculated as a function of SSD and depth. 2) The measurement of the contaminant gamma ray dose as a function of depth in water. 3) The measurement of LET spectra at three depths of water. The variation of RBE and oxygen enhancement ratios (OER) with depth were calculated from and compared with values using HeLa cells. ^{252}Cf medical neutron sources were evaluated for application to implant radiotherapy including basic dosimetry measurements and, in support of preclinical radiobiology, apparatus was designed to meet specific dosimetric requirements. Construction and assembly of a tissue equivalent microcalorimeter were completed and initial measurements of the temperature stability were reported. A small prototype ultrapure germanium gamma camera utilizing the orthogonal strip geometry was under evaluation. Spatial resolution of within 4 mm was obtained for images of extended isotopic sources. Initial application to small mammalian organs were made. Representative images are presented along with data obtained from measurements of operational characteristics of the matrix array. Pulsed electron sources such as 600 kV field emission generators deliver doses in excess of 10^{6} rads in single pulses with duration times of a few nsec. When these sources are used to irradiate thin layers of cells, the measurement of absorbed dose is complicated by the associated high dose rates, the relatively low electron energy, and the thickness of the sample which may be only a few microns. In this laboratory the problem of measuring absorbed dose was investigated by using thin disks of Pilot-B. A thin foil absorbed dose calorimeter provided a calibration for the scintillator light output. Since the dynamic range of the scintillator system is quite large, it was possible to perform absorbed dose measurements over the large range of doses used for various radiobiological experiments. (auth)

7629 (RISO-261) DOSIMETRY TECHNIQUES IN THERMOLUMINESCENCE DATING. Mejdahl, V. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar 1972. 46p. Dep. NTIS (U. S. Sales Only).

The principles employed at Risø for dating of ceramics and heated stones from archaeological excavation sites are outlined. The accumulated exposure is evaluated from the thermoluminescence emitted by quartz and feldspar inclusions with a size of 0.3 to 0.5 mm. The environmental radiation and the radiation from radioisotopes embedded in the ceramics or the stones are measured by means of the TL phosphors $CaSO_4$: Dy and $CaSO_4$: Mn respectively. The dosimetry techniques and the preparation and properties of the two phosphors are described. The effect of a number of random and systematic errors associated with TL dating is discussed. (auth)

7630 MEASUREMENT OF ENERGY LOSSES, RADIATION LENGTH, AND ELECTRON GRANULATION IN NUCLEAR EMULSIONS. Tsai-Chu; Hardev Singh Virk (Univ., Paris). Compt. Rend., Ser. B; 275: No. 3, 165-7(17 Jul 1972). (In French).

Energy losses were measured using the method of the center of gravity of the multiple scattering. The value of the electron radiation length in nuclear emulsions (3.15 ± 0.65 cm) is in agreement with the theory. (France)

7631 CALCULATIONS OF THE THERMAL PROCESSES IN CYLINDRICAL ABSORBERS OF CALORIMETERS. Kostyleva, Yu. G.; Mysev, I. P. Yadern. Priborostr.; No. 13, 87-117(1970). (In Russian).

Studies were made as a consequence of the resolution of the equation of thermal conductivity for homogeneous absorbers operating in non-stationary and stationary regimes. The dependence of the sensitivity of the absorber on the position of the thermometer and on the form of the distribution of the thermal sources in the absorber was examined. The optimum position of the thermometer and the placing and form of the electrical heater, used during the calibration, were selected. The effect of the form and material of the cylinder on the thermal parameters of the absorber was investigated, and the effect of the non-stable temperature of the casing on the temperature field of the absorber was calculated. The results are illustrated for the example of complete absorption calorimeters designed for the registration of electron beams with energy from 1 to 20 MeV. (tr-auth)

7632 DISPERSED DETECTOR FOR THE INDIVIDUAL THERMOLUMINESCENT DOSIMETRY OF NEUTRONS. Kazanskaya, V. A.; Kuz'min, V. V.; Makarov, Yu. A.; (and others). Yadern. Priborostr.; No. 13, 118-22(1970). (In Russian).

A dosimetric detector with thermoluminophors dispersed in thermostable hydrogenous material is described. The basic parameters of the detector-dependence of the sensitivity on the concentration of the luminophor, dose dependence, statistical variance of the sensitivity, and hardness dependence to γ radiation and neutrons-were determined. The optimum volumetric concentration of the luminophor appears to have the value 300 mg/cm^3, with which the statistical variance of the sensitivity of the detector is ±7.4%. The detectors have a linear dose characteristic in the region from 50 mrem to 5 krem. The sensitivity of the detector to 1 rem neutron equivalent dose is almost constant in the energy range from 50 keV to 4.5 MeV. Lead filters (0.64 mm) compensate hardness dependence to ±20% limits for γ radiation from 100 keV to 1.25 MeV. (tr-auth)

7633 PORTABLE METER OF THE EXPOSURE DOSE RATE OF GAMMA RADIATION WITH SEMICONDUCTOR DETECTORS. Vasil'ev, S. N.; Chistyakov, M. I. Yadern. Priborostr.; No. 13, 3-13(1970). (In Russian).

The hardness dependence of devices for the measurement of the dose rate of γ radiation using silicon-based semiconductor detectors was evaluated. The experimentally obtained relation is reported and the circuit of the portable dose rate meter is described. Its basic characteristics including hardness dependence, anisotropy, and dose characteristics were determined. (tr-auth)

7634 PROCEEDINGS OF THE SIXTH CONFERENCE OF THE NORDIC ASSOCIATION OF CLINICAL PHYSICS, AARHUS, DENMARK, AUGUST 20, 1970. Madsen, C. B.; Linden, K. (eds.). Acta Radiol., Suppl.; No. 313, 1-289(1972). (CONF-700860).

Separate abstracts are prepared for 20 papers. (C.E.S.)

For abstracts of individual papers see: 7605-7608, 7635-7643, 7654, 7673, 7697, 7958, 7959, 7964, and 7995.

7635 INSTRUMENT FOR DOSE RATE MEASUREMENTS IN GYNAECOLOGIC RADIATION THERAPY. Bengtsson, B. E.; Arvidsson, B.; Johansson, K.-A. (Univ., Goteborg). Acta Radiol., Suppl.; No. 313, 42-7(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

A dosimeter for use in gynecologic radiation therapy is described. A commercial rectifier diode was used as the detector and the signal is fed to an operational amplifier and indicated on a moving coil meter. The instrument has a battery power supply and a range of 0-200 rad/h. (auth) (Sweden)

7636 SKIN DOSES FOR ELECTRONS IN THE ENERGY RANGE 10 TO 33 MeV. MEASUREMENTS WITH THERMOLUMINESCENCE DOSIMETERS. Dahler, A.; Bengtsson, B. E.; Lindskoug, B. (Univ., Goteborg). Acta Radiol., Suppl.; No. 313, 48-50(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

Skin doses for electrons in the energy range 10–33 MeV have been measured with LiF (type Harshaw extruded) on a BBC betatron (Asklepitron 35). (auth) (Sweden)

7637 DEPTH DOSE NEAR THE SURFACE BY FAST ELECTRON IRRADIATION. MEASUREMENTS WITH THERMOLUMINESCENCE DOSIMETRY. Hvolby, J. (Radium Centre, Aarhus, Denmark). Acta Radiol., Suppl.; No. 313, 60-2(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

The depth dose in polystyrene by electrons of incident energy between 10–35 MeV has been measured for small depths. (auth) (Sweden)

7638 DIGITAL ELECTROMETER. Johansson, K. A.; Bengtsson, B. E.; Lindskoug, B. (Univ., Goteborg). Acta Radiol., Suppl.; No. 313, 76-9(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

An automatically integrating digital electrometer is described. It measures the instantaneous dose rate at the same time as it integrates the dose. Data on linearity and reproducibility are presented. The electrometer is in the first place intended for measurements on radiation therapy equipment together with an 0.6 cm^3 ionization chamber. (auth) (Sweden)

7639 RADIATION DOSIMETRY WITH EXOELECTRON EMITTING MATERIALS. Samuelsson, Ch. (Univ., Lund, Sweden); Ennow, K. Acta Radiol., Suppl.; No. 313, 127-34(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

The counting characteristics of a gas-flow point counter and the design of a thermally stimulated exoelectron emission dosimeter are given. Dosimetric properties, such as linearity, fading and reproducibility of the exoelectron emitting material are discussed briefly as well as the eventual application of exoelectron emission in radiation dosimetry. (auth) (Sweden)

7640 SMALL GAS-TIGHT IONIZATION CHAMBERS FOR ABSORBED DOSE CONTROL DURING RADIATION THERAPY. Wickman, G. (Univ., Umeaa, Sweden). Acta Radiol., Suppl.; No. 313, 152-7(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

Condenser ionization chambers incorporating a styrene copolymer as dielectric material, and conducting epoxy resin as electrode material have been developed. The chambers can be charged and read without affecting the ionization volume. The ionization volume is hermetically sealed and the calibration is practically independent of pressure and temperature. Preliminary results concerning the performance of the chambers are given. (auth) (Sweden)

7641 SPECTRUM STABILIZATION ON A WHOLE BODY COUNTER WITH THREE DETECTORS. Baerenholdt, O. (Glostrup Sygehus, Copenhagen). Acta Radiol., Suppl.; No. 313, 199-201(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

A method of stabilizing a gamma spectrum to secure the identity between the gamma ray energy and the respective channel number in a multichannel analyzer is presented. (auth) (Sweden)

7642 TRANSIT DOSE IN EXTRACORPOREAL BLOOD IRRADIATION DEVICES MEASURED BY MEANS OF THERMOLUMINESCENCE. Boetter-Jensen, L.; Christensen, P. (Danish Atomic Energy Commission, Risoe). Acta Radiol., Suppl.; No. 313, 247-52(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

A thermoluminescence system is described which has been developed to determine the transit dose from extracorporeal blood irradiation devices for immunosuppressive treatment and treatment of leukemia. Measurements have been obtained from three different blood irradiation systems supplied with ^{60}Co and ^{137}Cs gamma sources. Experiments were made with lithium borate powder suspended in demineralized water which was pumped through the irradiation devices under the same conditions as the blood. The method has shown a high degree of reliability in the calibration of irradiation systems for fluid media owing to a simple and manageable measurement setup and a good reproducibility. (auth) (Sweden)

7643 DOSIMETRY BY EXTRACORPOREAL IRRADIATION OF BLOOD. Munk, J. (Odense Sygehus, Denmark). Acta Radiol., Suppl.; No. 313, 260-4(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

Ferrous sulphate has been used as a dosimeter in order to determine the absorbed dose in the blood by extracorporeal irradiation. The radiation source was a 250 kV roentgen therapy unit, and the G-value for this radiation quality was investigated. The response of the dosimeter solution exposed to known radiation as well as its behavior in contact with silastic tubes, were examined. (auth) (Sweden)

7644 EVALUATION OF GAMMA-RAY SPECTRA ON ELECTRONIC DESK-TOP CALCULATOR. Kapisovsky, V. Radioisotopy; 13: No. 4, 861-79(1972). (In Slovak).

The comparison of several methods for Ge(Li) spectrum peak position and area evaluation is performed. The errors of each evaluation are considered. The results of illustrative calculations are discussed. There are no essential differences between the methods under considerations for peak position evaluation. The evaluation of peak area can be somewhat improved if for background estimation smoothed values are used. (auth)

7645 EXPERIENCES WITH THERMALLY STIMULATED EXOELECTRON EMISSION DOSIMETERS IN ENVIRONMENTAL AND INCORPORATIONAL DOSIMETRY. Boros, L. (Orvosradiologiai Akademiai Tanszeki Kutatocsoport, Budapest); Szy, D. Izotoptechnika; 15: No. 6, 319-22(Jun 1972). (In Hungarian).

The construction of a highly sensitive, LET-dependent dosimeter for measuring doses of μrad order of magnitude is described. A differentiation of radiations with different LET values by the analysis of glow curves is discussed. (auth)

7646 INTEGRAL METHODS OF FAST NEUTRON PERSONNEL DOSIMETRY. II. SURVEY OF STUDIES AND ANALYSIS OF NEW POSSIBILITIES. Spurny, Frantisek (Lab. of Radiological Dosimetry, Prague). Jad. Energ.; 18: No. 11, 377-85 (Nov 1972). (In Czech).

Methods studied in laboratories are presented. Recombination ionization chambers, radiation elements, thermoluminescence, photoluminescence and exoelectron emission dosimetry, methods based on radiation effects in organic solid state and methods of chemical dosimetry are reviewed. Desired characteristics of radiation effects applicable to fast neutron personnel dosimetry are discussed and new possibilities are proposed. (auth)

7647 CALIBRATION OF LiF TEFLON RODS FOR INTERNAL LiF β-RAY DOSIMETRY. Greitz, U. (Foersvarets Forskningsanstalt, Stockholm); Ruden, B. I. Phys. Med. Biol.; 17: No. 2, 193-7(Mar 1972).

Calibration of LiF Teflon rod dosemeters was performed in pure electron radiation fields. The dosemeters were immersed in solutions of ^{35}S, ^{99}Tc, ^{204}Tl, ^{32}P and ^{90}Y. The mean β-energy covered the range 0.5 to 0.90 MeV. The investigation resulted in calibration factors depending on the mean β-energy over the entire range studied; the variation was probably due to self-shielding. The results are in good agreement with theoretical calculations by other workers. As it is of interest for in vivo dose measurements to express the doses delivered to the walls of the gastro-intestinal tract, the energy calibration was also performed with the dosemeters pressed against the side of the exposure vessel. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 8038, 8518, and 8555.

7648 FINE SPECTRUM MEASUREMENTS. Schmitt, A.; Leridon, A.; Duquesne, H. (CEN, Cadarache, France). Bull. Inform. Sci. Tech. (Paris); No. 170, 21-30(May 1972). (In French).

Neutron spectrometry has been used in recent years as an additional parameter to conventional neutron balance measurements. Proton recoil and time-of-flight techniques are described together with the problems encountered in their utilization. (France)

7649 MULTICHANNEL ANALYZER WITH DIGITAL WINDOW FOR ACTIVATION ANALYSIS. Rogushin, I. I.; Kuznetsov, K. F.; Kozyr, A. I.; Sirota, A. A. Yadern. Priborostr.; No. 13, 42-53(1970). (In Russian).

Methods for the selective registration of part of the spectrum of nuclear radiation—the digital window methods—are examined. A method for the selection of the digital window with a method of setting two adjacent zones is proposed. It is shown that the maximum error of discreteness with setting of the digital window by the method of two adjacent zones is negligible (~10%). The circuits of the selection block, which can operate together with different amplitude input circuits, are given. (tr-auth)

7650 ANALYSIS WITH USE OF SEMICONDUCTOR DETECTORS AND X-RAY TUBES. Baldin, S. A.; Ioannesyants, L. M. Yadern. Priborostr.; No. 15, 44-9(1971). (In Russian).

The possibility of the use of low-power x-ray tubes as a source for the excitation of radiation and semiconductor detectors for element analysis of the composition of a substance was examined. It was shown experimentally that the use of the secondary emitter makes it possible to increase several-fold the threshold sensitivity. The possibility of the use of standard x-ray apparatus to increase the sensitivity of the analyzer (use of thin samples, fast analysis on mobile tapes, etc.) is discussed. (tr-auth)

7651 SPECTROMETER FOR LOW ENERGY PROTONS. Ol'dekop, L. G.; Polenov, B. V.; Khazanov, B. I. Yadern. Priborostr.; No. 15, 3-10(1971). (In Russian).

A proton spectrometer designed for measurement of the spectral distribution of protons with energy from 40 to 7000 eV with flux density from 1.8×10^4 to 1.8×10^8 particles/(sec · cm^2) is described. A modulation trap with collector is used as a detecting block. For reduction of the noise from uv radiation and particles of other sorts, protons, passing the energy selection system, are deflectively supplementary in the field of an electrostatic condenser. The registration of the collector current is done by a narrow-band alternating current amplifier with synchronous rectification. (tr-auth)

7652 AMPLIFIER CHANNEL FOR X-RAY SPECTROMETER WITH COOLED SILICON SEMICONDUCTORS. Baldin, S. A.; Ioannesyants, L. M. Yadern. Priborostr.; No. 15, 34-9 (1971). (In Russian).

The amplifier channel of an x-ray spectrometer with a silicon semiconductor detector, including the preamplifier with cooled head cascade and amplifier with active filter and fixed component regenerator, is described. The resolution of the spectrometer together with the semiconductor detector is 690 eV for the photopeak of the 13.94-keV line (^{241}Am) and 590 eV for the generating peak. (tr-auth)

7653 INTEGRATED COINCIDENCE SPECTROMETER WITH SEMICONDUCTOR DETECTORS. Aloev, A. S.; Vartanov, N. A.; Stugarev, Yu. N. Yadern. Priborostr.; No. 15, 100-6(1971). (In Russian).

An integrated coincidence spectrometer in which large volume Ge(Li) detectors are used is examined. The operation of the spectrometer was feasible both in the slow coincidence mode and in the fast-slow coincidence mode. A comparison was made of the efficiency of the registration in the one-crystal regime and in the integrated coincidence regime with the use of NaI(Tl) crystals of different diameter (0 30 × 20, 0 40 × 40, and 0 120 × 100 mm) and Ge(Li) detectors with volumes of 56 and 65 cm^3. (tr-auth)

7654 RADIONUCLIDE IMAGING PROCESS. Mallard, J. R. (Univ. of Aberdeen, Scotland). Acta Radiol., Suppl.; No. 313, 158-92(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

The radionuclide imaging process is reviewed and considered as an information flow; it can be usefully evaluated from the line spread function of each component; the plane sensitivity can be calculated and also the variation of modulation transfer functions to give a measure of spatial resolution. The value of the technique is shown from results for focused collimators and gamma cameras. Brief notes are given concerning some topics which require more work. Equipment developments in hand include a digitally controlled visual display system, a section scanner and a fine resolution image intensifier gamma camera. (auth) (Sweden)

7655 SPECTRAL RESOLUTION IMPROVEMENT BY NON-DAMPING FILTER. Inouye, T. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). Nucl. Instrum. Methods; 104: No. 3, 541-4(1972).

A new method for the spectral resolution improvement is described. The difficulty that appears in the usual method for the resolution improvement is eliminated by use of the characteristic of the delta function. Results of the numerical simulation show the effectiveness of the proposed method using a non-damping filter function. (auth)

7656 TRIPLE AXIS NEUTRON SPECTROMETER, TYPE TKSN 400. Petrzilka, Vaclav (Charles Univ., Prague); Michalec, Rudolf; Chalupa, Bohumil; (and others). Jad. Energ.; 18: No. 11, 367-70(Nov 1972). (In Czech).

The Triple axis neutron crystal spectrometer, type TKSN-400, as well as the results of first experiments which have been carried out on this apparatus, are described. (auth)

7657 DEVICE FOR IMPROVING THE ION DETECTION EFFICIENCY OF A SIMPLE FOCUSING MASS SPECTROGRAPH. Eloy, Jean-Francois; Roth, Etienne (to Commissariat a l'-Energie Atomique). French Patent 2,102,761. 7 Apr 1972. Filed 20 Aug 1970. (In French).

A process for deepening the blackening produced by ion means on the photographic plate of a mass spectrometer is presented. Just before the impact of the ion beam on the photographic plate the ion beam is subjected to an electric field which increases the kinetic energy of the incident ions by a post-acceleration effect and enhances the focusing of the beam in order to increase the ion density at the photographic plate. (France)

7658 PERFORMANCE OF A QDDD SPECTROGRAPH. Wiedner, C. A. (Max-Planck-Institut fuer Kernphysik, Heidelburg); Goldschmidt, M.; Rieck, D.; Enge, H. A.; Kowalski, S. B. Nucl. Instrum. Methods; 105: No. 2, 205-10(1972).

A new type magnetic spectrograph for charged-particle nuclear-reaction studies has been put into operation in conjunction with the Heidelberg MP-Tandem Van de Graaff accelerator. The main elements of the spectrograph are a quadrupole magnet and three dipoles (deflecting magnets). It is therefore called the QDDD or Q3D spectrograph. The instrument has an acceptance solid angle of 13 msr, a range $E_{max}/E_{min} = 1.21$ and a resolving power of the order of $p/\Delta p = 10^4$. Other features of the instrument include a multipole used for magnetic correction of kinematic broadening and other aberrations and an electrostatic deflector for separation of particles according to their specific mass m/q. (auth)

7659 ENERGY RESOLUTION OF A MULTIWIRE PROPORTIONAL QUANTAMETER. Katsura, T. (Univ. of Hawaii, Honolulu); Parker, S.; Peterson, V. Z.; Yount, D. E.; Stevenson, M. L. Nucl. Instrum. Methods; 105: No. 2, 245-52(1972).

The energy resolution and certain other characteristics are evaluated for an electromagnetic-shower detector consisting of multiwire proportional chambers interleaved between lead plates. Such a detector preserves the energy linearity, angular isotropy, and position uniformity of the standard ion-chamber quantameters used in monitoring photon beams, and in addition, it can determine the point of incidence, the time of arrival, the detailed spatial shower development, and the total energy of individual gamma rays. The energy resolution is, however, significantly broader than for the corresponding shower counter in which plastic scintillators are used between lead plates. This can be understood in terms of a simple model that takes into account fluctuations in ionization in the thin detector planes as well as fluctuations in the number of shower tracks sampled. (auth)

7660 4π β-γ-COINCIDENCE SPECTROMETER USING Si(Li) AND NaI(Tl) DETECTORS. Gils, H. J.; Flothmann, D.; Loehken, R.; Wiesner, W. (Univ., Heidelberg). Nucl. Instrum. Methods; 105: No. 2 179-88(1972).

The well-tested method of measuring β-spectra with Si(Li) semiconductor detectors in 4π geometry is extended to inner β^--spectra and positron decays by applying coincidence techniques. For this purpose a 4π β-γ-coincidence spectrometer has been constructed. The radioactive source and the two 2π Si(Li) β-detectors are put together in a sandwichlike arrangement. The γ-quanta, emitted in coincidence with the β-particles, are detected by two large NaI(Tl) scintillation counters, which cover a solid angle of $0.6 \times 4\pi$ with respect to the source. A sluice enables the source to be quickly brought into the vacuum chamber, so that short-lived decays with halflives down to one minute can be measured. The characteristics of the coincidence spectrometer are checked by measuring the β^--spectrum of ^{24}Na and the positron spectrum of ^{22}Na. The results are in good agreement with those obtained by other methods and show the reliability of the apparatus. (auth)

High Energy Physics Instrumentation

Refer also to abstract 7987.

7661 (AD-741761) SPARK CHAMBER SPECTROMETRY AND SPACE RADIATION STUDIES. II. Final Report, December 1, 1970–November 30, 1971. Madey, R.; Baldwin, A. R.; Huetter, G. T.; Yushak, S. M. (Clarkson Coll. of Tech., Potsdam, N. Y. Dept. of Physics). 31 Mar 1972. Contract F19628-71-C-0080. 89p. (CPDD-72-1; AFCRL-72-129). NTIS.

A data acquisition system for a spark-chamber spectrometer, which consists of a unidirectional spark-chamber range telescope with differential pulse-height analysis of the specific energy loss of a charged particle that passes through the triggering telescope is described. Also described are the concept, design, construction, and performance of pulsed spark-discharge modules; the performance characteristics of a high-voltage pulse generator; a study on the interpretation of previous measurements of the fluctuations in the energy loss of 66 and 100 MeV protons in a thin proportional counter; some representative experiments that

would utilize spark chamber instrument systems for the measurement of charged particle spectra in and/or above the atmosphere; and the results of two studies on visual sensations induced in the dark-adapted eye by heavy cosmic-ray nuclei. (auth) (GRA)

7662 (IFVE-SPK-71-75) PROPANE-FREON BUBBLE CHAMBER SKAT (PROJECT). Barabashev, A. Z.; Gerdyukov, L. N.; Danil'chenko, I. A.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 55p. (In Russian). Dep. NTIS (U. S. Sales Only).

A propane-freon bubble chamber SKAT with the working volume of 4500 × 1300 × 1100 mm^3 is described. Four cameras take pictures of the chamber through a 2.5 m layer of water, filled in the safety volume, and through a traveling glass 140 mm thick. Two objectives take pictures of the whole volume of the chamber. The pressure is varied through a common membrane by 25 valves. A magnet with the voltage strength of the magnetic field of 25 to 27 kgauss, its power consumption 8.4 to 14 mW, has been designed for the chamber. (auth)

7663 (ITEF-922) METHOD OF EXTRACTING INFORMATION FROM WIRE SPARK CHAMBERS IN A MAGNETIC FIELD. Korol'kov, I. Ya.; Novikova, N. V.; Nozdrachev, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

Characteristics of the method for extracting information from wire spark chambers in a magnetic field are presented. The method developed may be applied to filmless processing of the information from large magnetic spectrometers. (auth)

7664 (JINR-E1-6633) HIGH RESOLUTION LEAD GLASS CHERENKOV GAMMA-SPECTROMETER. Astvatsaturov, R. G.; Ivanov, V. I.; Khachaturyan, M. N.; Kramarenko, V. A.; Kulakov, B. A.; Malakhov, A. I.; Melkumov, G. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 9p. Dep. NTIS (U. S. Sales Only).

Lead glass Cherenkov gamma spectrometers of a new configuration were tested using an electron beam. The data on the energy resolution for electron energies of 2 and 4 GeV (7.2% and 5.1% respectively) and also on the discrimination power against hadronic background are presented. (auth)

7665 (LA-5072) SPECTROMETER DESIGN AT LASL. Thiessen, H. A.; Klein, M. M. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 13p. Dep. NTIS.

The results of recent work at Los Alamos in the area of spectrometer design are reviewed. Included are reports of results of bending magnet design using H_t-windings for fine adjustment of the field uniformity, high quality quadrupole design, and high resolution detectors. Details of an optimizing ray tracing program called MOTER are discussed, and several recent results obtained with this program are given. It is believed that the techniques reported represent significant developments in the technology of spectrometer design and have important applications in the areas of medium energy and high energy physics. (auth)

7666 (UH-511-133-72) SHOWER COUNTER FOR NAL EXPERIMENT 87. Harris, F.; Hyder, D.; Yount, D. (Hawaii Univ., Honolulu). Sep 1972. Contract AT(04-3)-511. 12p. Dep. NTIS.

Specifications and design parameters are given for a lead-scintillator shower counter to be used in determining the photon energy spectrum in NAL Experiment 87. The gain per GeV is expected to be independent of beam energy to ±1% from 1 to 500 GeV and to be independent of beam position to ±1% over a radius of 10 cm, twice the design radius, measured from the nominal beam axis. The energy resolution is expected to have a Gaussian standard deviation of about $20\% \times E^{-\frac{1}{2}}$, where E is the incident photon energy in GeV. An energy resolution with twice this deviation would change the measured photon intensity per energy interval, dn/dE, by less than 1% for energies up to 300 GeV. (auth)

7667 ANALYSIS PROCEDURE OF GAMMA RAY ASTRONOMY SPARK CHAMBER DATA. Pinkau, K. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Nucl. Instrum. Methods; 104: No. 3, 517-23(1972).

An analysis procedure is presented for the measurement of gamma ray arrival directions in spark chambers. This method is based on the conception that data are not used for measurement once multiple scattering has overtaken the reading error. The relevant formalism is presented and lower limits of the possible angular resolution are given. (auth)

7668 POSSIBILITY OF USING SUPERCONDUCTING NEURISTOR LINE AS PARTICLE DETECTOR. Drukier, A. K. (Univ. of Copenhagen). Nucl. Instrum. Methods; 104: No. 3, 593-5(1972).

It is proposed that position sensitive detectors of relativistic, charged particles are a new, very promising application of superconducting devices. The characteristics of such detectors can be immediate electronic readout, high spatial resolution $5\ \mu m \leq \Delta x \leq 20\ \mu m$, high temporal resolution $t \sim 10^{-7}$ s. A new kind of detector, a superconducting tunnel junction stripline, which performs better than a detector based on change of state from superconducting to normal in thin films (wires) just below critical temperature, is proposed. (auth)

7669 RELATION BETWEEN RESTRICTED ENERGY LOSS AND TRACK WIDTH IN NUCLEAR EMULSIONS. Jensen, M.; Larsson, L.; Rosander, R. (Univ. of Lund, Sweden). Nucl. Instrum. Methods; 104: No. 3, 611-13(1972).

The restricted energy loss of charged particles is a useful parameter in the description of heavy ion tracks and in the calibration of mean track width measurements in nuclear emulsions. (auth)

7670 CONTRIBUTION TO THE DETERMINATION OF THE PARTICLE'S ENERGY IN PHOTOGRAPHIC EMULSION. Plsek, Fr.; Tucek, J. (Safarik Univ., Kosice, Czech.). Czech. J. Phys.; 22: No. 10, 1017-19(1972).

The irradiation of photographic emulsions by the Serpukhov Synchrotron shifted the investigation of interactions with known primary energy into the area which has previously been the domain of cosmic radiation. The primary energy of interacting π^- mesons ($p = 60$ GeV/c) was compared with values given by methods described by Castagnoli and Petrzilka. The Lorentz-factor γ_c of the center of mass system was determined to be 5.73 on the assumption that π^- meson collides with a nucleon. The energy of the primary particle can be calculated if the particles of the collision are known. (F.S.)

7671 SIMPLE π^+ DETECTOR FOR ENERGIES OF 10 TO 70 MeV. Saltmarsh, M. J. (Oak Ridge National Lab., TN); Preedom, B. M.; Edge, R. D.; Darden III, C. W. Nucl. Instrum. Methods; 105: No. 2, 311-15(1972).

A simple π^+ detector telescope based on NE102A plastic scintillator has been developed for use in the energy range 10-70 MeV. The detector has a relatively high efficiency ($\gtrsim 74\%$), a useful degree of particle identification, and a resolution capability ($\lesssim 1$ MeV fwhm) sufficient for a number of nuclear physics applications using high quality pion beams, such as those which will be available at the Los Alamos Meson Physics Facility. (auth)

Radiometric Instruments

Refer also to abstract 7576.

7672 QUESTIONS ON THE EVALUATION OF THE PRECISION OF THE RADIOMETRIC SUBTRACTING DEVICE. Gertsovskii, A. F.; Klimov, A. N. Yadern. Priborostr.; No. 15, 59-65(1971). (In Russian).

Expressions describing the operation of radiometric subtracting devices in steady state conditions are given. It is shown that the operation of the circuit given is described on the whole by expressions for simple circuits. The final results were obtained by methods used to analyze both the stationary state of the circuit and its transitory processes. (tr-auth)

7673 MINERAL CONTENT IN BONE, MEASURED BY MEANS OF 27.5 keV RADIATION FROM ^{125}I. Jensen, H.; Christiansen, C.; Lindbjerg, I. F.; Munck, O. (Glostrup Sygehus, Copenhagen). Acta Radiol., Suppl.; No. 313, 214-20(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

The bone mineral content was determined by means of 27.5 keV radiation from ^{125}I. In normal subjects, the coefficient of variation based on measurements on calcaneus within the same day was 0.5 to 1.7%, and the day to day variation was 0.6 to 1.9%. In 5 control subjects, the mineral content in calcaneus was 44 to 55 absorption units and in 12 patients with bone diseases of different origin it was 5 to 23 absorption units. The method is suited for clinical routine use. (auth) (Sweden)

7674 DEVICE FOR ELIMINATING ELECTRICAL CHARGES. Bertein, Helene; Hours, Richard (to Commissariat a l'Energie Atomique). French Patent 2,102,683. 7 Apr 1972. Filed 14 Aug 1970. (In French).

A device for eliminating static electricity from highly charged materials, possibly in rapid motion (e.g., fabrics, paper, thin plastics) is described. The process consists of using an induction eliminator to eliminate the majority of the charges, the remaining

residual charges being eliminated with a radioactive eliminator. The two eliminators are arranged in such a way as to obtain a convenient distribution of the lines of force of the electrically charged material. The radioactive source is used in conjunction with highly curved surfaces (sharp edges, points, or fine wires). These surfaces as well as the other collector electrodes are earthed. (France)

7675 SENSITIVITY IN ELECTRON MICROSCOPE AUTORADIOGRAPHY. I. THE EFFECT OF RADIATION DOSE. Salpeter, M. M.; Szabo, M. (Cornell Univ., Ithaca, N. Y.). J. Histochem. Cytochem.; 20: No. 6, 425-34(1972).

Sensitivity in electron microscope autoradiography using Ilford L4 emulsion was shown to be affected by radiation dose (i.e., number of decays in test specimen per unit surface area). The sensitivity tended to be higher with lower doses. This dose dependence was most marked with Microdol X and least with gold latensification–Elon ascorbic acid development. Possible consequences for quantitation in electron microscope autoradiography are discussed. (auth)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to abstract 9143.

7676 INFLUENCE OF γ RADIATION ON THE SURFACE PROPERTIES OF THE STRUCTURE METAL-DIELECTRIC-SEMICONDUCTOR. Litvinov, R. O.; Litovchenko, V. G.; Kornyushin, S. I.; Gerasimov, A. B.; Shillo, A. G. (Inst. of Semiconductors, Leningrad). Poluprov. Tekh. Mikroelektron.; No. 8, 51-7(1972). (In Russian).

Assemblies of metal/dielectric/semiconductor (MDS) were prepared for the purpose of evaluating the effect of γ radiation on them. n or p-type Si was used in conjunction with one of the following dielectrics: SiO_2, Al_2O_3, or the two-layer $Si_3N_4 + Al_2O_3$. The MDS samples were irradiated with 10^4 to 10^6 R of ^{60}Co radiation. Conclusions were drawn regarding the mechanism of the centers produced by the radiation. (K.S.W.)

7677 EFFECT OF CHARGE EXCHANGE BETWEEN DEEP CENTERS NEAR A p–n JUNCTION OF THE PROPERTIES OF GERMANIUM γ-RAY DETECTORS. Karpenko, V. P.; Kasherininov, P. G.; Matveev, O. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 6: No. 1, 93-5(Jul 1972). Translated from Fiz. Tekh. Poluprov.; 6: No. 1, 116-19(Jan 1972).

The polarization of the space-charge region of p–n junctions in Ge during γ irradiation was studied. The parameters of the impurity centers responsible for this effect in especially pure Ge, as used in the fabrication of γ-ray detectors, were determined. It is shown that the polarization charge in detectors of this type may appreciably impair their energy resolution. (auth)

7678 POLARIZATION OF THE SPACE-CHARGE LAYER IN n–p (n–i–p) DETECTORS DURING IRRADIATION. Karpenko, V. P.; Kasherininov, P. G.; Makovskii, L. L.; Matveev, O. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 6: No. 1, 87-92(Jul 1972).

Translated from Fiz. Tekh. Poluprov.; 6: No. 1, 109-15(Jan 1972).

An analysis is made of the distribution of the polarization charge density across the thickness of the space-charge layer associated with a junction in a nuclear particle detector. This distribution is obtained for a junction illuminated with light corresponding to the fundamental absorption region or bombarded with γ rays. It is shown that when the generation of electron-hole pairs across the space-charge layer is uniform, the polarization charge obtained after complete charge exchange between the appropriate centers is distributed uniformly across the junction irrespective of the nature of the junction. The polarization charge density is equal to the concentration of deep levels at which this charge is localized. Relationships are obtained between the parameters of such deep levels and the electrical properties (capacitance) of the junction. (auth)

7679 PHOTOEMISSION STUDIES AT RT OF X-IRRADIATED MOS STRUCTURES. Kreutz, E. W. (Technische Hochschule, Darmstadt, Ger.). Phys. Status Solidi (a); 13: No. 2, 557-67 (16 Oct 1972).

At room temperature, changes of drain current and of transfer characteristics were measured during illumination with visible and uv light in commercially available Si-n-channel MOSFETs. The threshold energies of the excitation mechanisms causing positive and negative changes of drain current were determined by a photoelectric technique. Electron excitation from the Si conduction as well as from valence band into the overlying SiO_2 and discharging of oxide traps are responsible for negative and positive drain current changes. The photoelectric threshold energies are characteristically influenced by x irradiation, depending on the sign of the radiation-induced drain current changes. The results are compared with the different concepts involved in the generation of defects in SiO_2. (31 references). (auth)

7680 EFFECT OF DIFFERENT KINDS OF RADIATION ON VELOCITY AND ATTENUATION OF ELASTIC WAVES IN QUARTZ AND DKT. Krebs, M. (Coll. of Mechanical and Textile Engineering, Liberec, Czech.). Fyz. Cas.; 21: No. 2-3, 132-5(1971).

The effect of neutron, X- and γ-radiation on the properties of quartz and DKT piezoelectric resonators was studied. X-irradiation was found to result in a decreased frequency. Various types of microstructural mechanisms are believed to take place during neutron irradiation. Changes in the dissipative mechanism of piezoelectric resonators are assessed. They were found to be so small that they could not explain the changes of resonance frequency observed during X- and γ-irradiation. The phenomenon is explained by microstructural considerations. (NSA of Czech.)

7681 LATENT SUB-IMAGES IN PHOTOGRAPHIC FILMS EXPOSED TO ^{60}Co GAMMA RAYS. Callaby, D. R. (3M Italia Research Labs., Ferrania, Italy). J. Photogr. Sci.; 20: No. 5, 157-66(Sep 1972).

Measurements were made of the amount of sub-image grains present in photographic films after exposure to γ-rays from a cobalt-60 source. It was found that the ratio of grains with sub-images to those with a full latent image was low when the mean grain size of the emulsion was more than 0.5 microns in diameter but rose rapidly to values above unity for emulsions having mean grain sizes less than 0.4 microns. The results show that on average the electrons produced by the γ-rays must travel at least 0.3 microns within a grain of the emulsion to produce a latent image. It also follows that grains of diameter less than 0.3 microns need to interact with more than one high energy electron to produce a latent image. (auth)

Miscellaneous Instruments

Refer also to abstract 7978.

7682 (COO-3158-14) 10 NSEC RESOLUTION COUNTER FOR MULTIPARTICLE ATOM PROBE TIME-OF-FLIGHT MEASUREMENTS. Berger, A. S. (Cornell Univ., Ithaca, N. Y. Materials Science Center). 1 Nov 1972. Contract AT(11-1)-3158. 9p. Dep. NTIS.

The atom probe field ion microscope allows single atom identification by combining a field ion microscope with a time-of-flight mass spectrometer. A circuit is described which provides time resolution of ±10 nsec in an interval of 100 μsec for up to 8 particles arriving at the detector in any one field evaporation pulse cycle. The duty cycle of the instrument is limited only by the data recording system. The ±10 nsec resolution allows identification of species separated by one mass unit under the worst case conditions of high atomic weight and high accelerating voltage. (auth)

7683 (KFK-1641) CAMAC: SPECIFICATION OF AMPLITUDE ANALOGUE SIGNALS. EXTENSION OF THE SPECIFICATION OF AMPLITUDE ANALOGUE SIGNALS (EUR 5100 [1972]) AND COMMENTS OF THE ESONE WORKING GROUP. Tradowsky, K. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Aug 1972. 23p. Dep. NTIS (U. S. Sales Only).

This document is written as an extension of the Specification of Amplitude Analogue Signals published as Euratom Report EUR 5100 and relates to signals which are recommended for use by CAMAC compatible units. It specifies amplitude analogue signals whose rise times are shorter than 50 ns (corresponding to a 3 dB upper cutoff frequency of approximately 7 MHz). A terminated 50 Ω system with 0 to −1 volt working range is recommended. The technical part of this recommendation has been agreed upon by the US AEC NIM Committee. (auth)

7684 (SC-DR-720803) PENDULUM FOR MEASURING BLOWOFF IMPULSE IN THE LABORATORY. Elrick, R. M.; Miller, D. W. (Sandia Labs., Albuquerque, N. Mex.). Oct 1972. 30p. Dep. NTIS.

Pendulum theory is reviewed and the design, calibration, and operation of a pendulum for impulse measurements are described. The performance of the pendulum for measuring the impulse from electron beam and laser induced blowoff is discussed. (W.H.K.)

7685 (TID-25877) SUPPLEMENTARY INFORMATION ON CAMAC INSTRUMENTATION SYSTEM. (Atomic Energy Commission, Washington, D. C.). Dec 1972. 44p. Dep. GPO $0.75.

Supplementary information to be used in conjunction with AEC Report TID-25875 (EUR 4100e, 1972), which describes the CAMAC modular instrumentation system for data handling, and AEC Report TID-25876 (EUR 4600e, 1972) which defines a CAMAC branch highway and crate controller is presented. Included are recommendations concerning the implementation and interpretation of the specifications and descriptions of preferred practices and current applications. This report does not modify the specifications referred to above. (auth)

7686 (Y-1856) AUTOMATION OF DATA COLLECTION AND COMPUTATION FUNCTIONS FOR MONOCHROMATIC X-RAY ABSORPTION ANALYSIS. Barringer, R. E.; Carver, D. W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 19 Nov 1972. Contract W-7405-eng-26. 21p. Dep. NTIS.

A small, dedicated computer which was interfaced to the spectrogoniometer and timer-scaler units of a monochromatic X-ray absorption analysis apparatus to perform the functions of data collection, computation, and a printout of the results is described. (auth)

7687 GAMMA HEATING EFFECT ON THERMOCOUPLES USED FOR TEMPERATURE FLUCTUATION MEASUREMENT IN TWO-PHASE FLOW. Nishihara, Hideaki (Kyoto Univ.); Takahashi, Osamu; Shirafuji, Nakao. Atomkernenergie; 20: No. 2, 159(1972).

Present status of the use of thermocouples as in-core sensors show that they could be used reliably at high temperatures and under adverse chemical and radiation fields. They can be used not only for direct temperature measurement, but also for detecting other physical quantities or reactor conditions, such as coolant flow rates or reactor noise signature. Reactor noise signature is considered to be one of the diagnostic tools of abnormality detection, and temperature noise signature can be used to detect coolant channel blockage or the onset of coolant boiling. A recently proposed "special thermocouple" detects voids in liquid metal coolant as well as the coolant temperature. Results, though preliminary in nature, indicate that if a properly fabricated thermocouple, susceptible to gamma radiation, is used as an in-core coolant temperature sensor, it can detect two-phase fluctuations more effectively under the gamma radiation. (F.S.)

7688 HIGH TEMPERATURE EXTENSOMETERS: THE ROKIDE PROCESS. Mes., Regul., Automat.; 37: No. 6, 87-96(Jun 1972). (In French).

High temperature gages are used in thermal and nuclear power plants, turboreactors and various technologies necessitating temperatures in excess of 300 deg C. Only problems concerning gages having nonorganic substrates are treated. The working principles of a gage are studied as a function of temperature. The principal gage alloys are cited (particularly Pt-W). The stability of the measurement points, the corrosion resistance, and the quality of the gage insulation with respect to earth are studied. Various methods of adhesion (Rokide process, inorganic adhesives) are adopted depending upon the temperature conditions, their ease of utilization, and the nature of the experiment (static or dynamic). The Rokide process consists of projecting ceramics (aluminas) using an oxyacetylene metallization pistol. An entirely different wiring technology must be used to protect the gages. The results that can be achieved with this technology in the study of high temperature stresses are indicated. (France)

7689 APPARATUS FOR ANALYZING RADIOACTIVE SAMPLES. Gouyen, Louis; Leblais, Rene; Le Gallic, Yves; Vatin, Robert (to Commissariat a l'Energie Atomique). French Patent 2,091,910. 21 Jan 1972. Filed 20 Apr 1970. (In French).

An apparatus for analyzing radioactive samples (in particular, in a given atmosphere, under vacuum, or in the presence of a gas, such as methane or an argon-methane mixture) is described. This apparatus consists of a vertical storage loading device (for the samples), a horizontal channel which crosses this loading device and connects it to a platform (which is free to move in the vertical plane), another horizontal channel situated between the platform and a detector that measures the activity of the sample, and a movable sample transfer part for these channels. The outer walls of the various components define a sealed enclosure. The atmosphere inside this enclosure is controlled by pipes traversing these walls. (France)

7690 PROCESSING OF MASS SPECTRA FOR ABRIDGEMENT OF EXCESS INFORMATION. Kononov, B. N. Yadern. Priborostr.; No. 15, 75-84(1971). (In Russian).

Methods of abridging excess information in telemass spectrometry are examined. It was shown that the use of exponential scanning in the case of radiofrequency mass spectrometers makes it possible to gain 4 to 6 times the mass range M_{max}/M_{min} equal to 10 to 20. The selection and indication of the peaks make it possible with 1.5 readouts in 1 amu to transmit spectra with an error in the determination of the mass number equal to ± 0.35. A device with condensation of the information, constructed on this principle, is described. The structure of the device with encoding and storage of the peak height and its corresponding mass number, guaranteeing the abridgement of the transmitted information by 1 to 2 orders of magnitude, is examined. (tr-auth)

7691 QUESTIONS OF THE NOISE CALCULATION AND CONSTRUCTION OF THE TRANSISTORIZED CHARGE AMPLIFIER. Sokolov, V. P.; Fedorchenko, S. N. Yadern. Priborostr.; No. 15, 18-33(1971). (In Russian).

On the basis of the analysis of the noise model of transistors with consideration of the internal feedback and resistor noise, the noises of a charge amplifier with resistance parallel feedback are calculated for the case of cascade construction of the primary cascade of the amplification and for circuits with common emitter. The advantage of the construction of the primary cascade of the amplification through a cascade wiring diagram is indicated. The difference of the noise characteristics of the amplification unit with feedback from the single cascade of amplification is shown. Formulas are introduced for the determination of the magnitude of the noise and parameters of the filters, close to optimum. The noise magnitude is calculated for different types of triodes and experimental graphic material is reported for the determination of the minimum noise characteristics of the amplifier from the emitter current of the first triode. The advantage of the construction of the primary cascade of the amplification on silicon triodes with low capacitance of the 2T312B type is shown and its operating regime is determined. Methods for the calculation of the charge amplifier with internal feedback are given. (tr-auth)

7692 INVESTIGATION OF THE CHARACTERISTICS OF AN ENERGY MASS SPECTROMETER FOR LOW ENERGY IONS. Bogdanov, A. V.; Vaisberg, O. L.; Polenov, B. V. Yadern. Priborostr.; No. 15, 11-17(1971). (In Russian).

The results of the calculation and experimental verification of the characteristics of a spectrometer for low energy ions are reported. Data on the energy resolution of the device and characteristics of the ion detector, in which was used the secondary electron multiplier VEU-1, are given. An evaluation is made of the distribution factor of different shapes of the magnetic selector. (tr-auth)

7693 METHODS FOR THE CONSTRUCTION OF A DURABLE MULTICHANNEL ANALOG MEMORY DEVICE. Ioffe, A. F.; Perfilov, V. A. Yadern. Priborostr.; No. 13, 77-86(1970). (In Russian).

Methods for the construction of multichannel analog memory devices on transfluxers with input of information without disruption are examined. Comparative evaluation of the different methods were made with consideration of the degree of commutation of the analog values and magnetization current, reliability of the address selection, number of active elements, etc. (tr-auth)

7694 USE OF THE POLYNOMIAL FORECASTER IN INSTALLATIONS FOR THE PROCESSING OF ANALOG INFORMATION. Ioffe, A. F.; Perfilov, V. A. Yadern. Priborostr.; No. 13, 66-76(1970). (In Russian).

An analog-digital converter with compression of the information on the magnetic element in which was realized a polynomial forecaster of zero order with floating aperture is described. The analysis of the error of the operation of the transformer is reported. It is indicated that the basic contribution introduces the character of the source of the entry and of the regime of magnetic reversal. (tr-auth)

7695 TRANSFORMER OF LOW DIRECT CURRENT IN PULSE REPETITION FREQUENCY. Ol'dekop, L. G. Yadern. Priborostr.; No. 13, 54-8(1970). (In Russian).

A description is given of the circuits of the low current digital meter. The sensitivity of the completed circuit is 10^{-12} amp/imp/sec. The measurement range is 10^{-12} to 5×10^{-8} amp. The input cascade and commutator of the discharge device of the circuit was realized on the electrometric tube EM-7 and the remaining cascade on transistors. The device was used for the collection of the discharge of the electrostatic analyzer. (tr-auth)

7696 STUDY AND DEVELOPMENT OF AN EMITTANCE METER. Delahaye, J. P. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 169, 61-77(Apr 1972). (In French).

The development of a very sensitive emittance meter for accurately and completely analyzing an ion or electron beam in two planes near to the source outlet is discussed. The equipment is used to study an h-f source, which is capacitively coupled and utilizes an axial magnetic field. An extraction model specially adapted to the geometrical and electrical conditions of the source is presented; this model takes into consideration the qualitative and quantitative effect of the principal parameters controlling the source on the extracted beam. (France)

7697 COMPUTERIZED SYSTEM FOR SCINTIGRAPHY. Beckman, K.-W.; Berne, E.; Liljenfors, B.; Vikterloef, K. J. (Regionsjukhuset, Oerebro, Sweden). Acta Radiol., Suppl.; No. 313, 193-8(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

Many different procedures are used for enhancing the interpretation of scans. The development of small economic computers has opened up new possibilities of improving the analysis of scans. Such a system is described which offers the possibility of working in an off- or on-line system in rectilinear scanning. The data may either be digitally printed out or presented on a TV display and photographed. The presentation may also be made on a color TV display. Normally the scan is presented in a 64 × 64 matrix. When making two registrations, e.g., for pancreas scan, this matrix may be divided into two separate matrices and the required subtraction of one activity from the other, point by point, using a preselected factor may be performed. The clinical experiences with the equipment are encouraging. It is fast and simple to handle. (auth) (Sweden)

7698 RAPID INJECTOR FOR PERMANENT RADIOACTIVE IMPLANTATION. Scott, W. P. (Charlotte Memorial Hospital, N. C.). Radiology; 105: No. 2, 454-5(Nov 1972).

A simple technique designed to overcome the difficulties inherent in standard implantation methods is presented. This technique may be used with any radioactive seeds now in use. (auth)

7699 DEVELOPMENT OF AN ANALOGUE SIMULATOR AND APPLICATION TO RADIOCARDIOGRAMS. Faisandier, Y.; Demarez, J. P.; Baillet, J. (Hopital Broussais, Paris). J. Biol. Med. Nucl.; 7: No. 28, 27-33(1972). (In French).

This analogue simulator displays permanently on a cathode tube screen, curves which correspond to the dilution functions of the cardiac cavities and lungs. The simulation of the radiocardiographic curves realized by means of scintillation probes, aimed each at two cavities, is obtained by modification of the parameters of each function. This examination does not involve any risk for the patient and gives the cardiac output, the volume of each cavity, the pulmonary transfer function and the mean transit time. (France)

7700 STUDY OF FAST IONIZATION GAGES USING AN ELECTRON BEAM FLUORESCENCE PROBE. Ohba, Kenkichi; Hirano, Keiichi (Osaka Univ.). Jap. J. Appl. Phys.; 11: No. 11, 1693-1700(Nov 1972).

Ionization gages with rapid response are developed to study the transient behavior of rarefied gas puffs injected from a fast acting gas valve. A standard densitometer is provided by detecting fluorescence signals in the puff stimulated by a 23 kV electron beam. It is found that a usual opened-6AH6 gage is not available for a fast ionization gage since disturbances caused by the gage head itself in the puff flow give some unfavorable effects on measurements. Four simple-shaped gage heads of different types are newly designed so that the gas puff may flow smoothly through them. A negative feedback loop is connected to the grid electrode to stabilize the electron current. The gage head with three co-axial grid-like electrodes and a hair-pin filament in its center is found to record the behavior of puffs accurately in the pressure range from 10^{-3} to 1 Torr. (auth)

7701 HIGH STABILITY SMALL CURRENT GENERATOR. Dalmazzone, J. (to Commissariat a l'Energie Atomique). French Patent 2,102,822. 7 Apr 1972. Filed 24 Aug 1970. (In French).

An electric generator for small currents is presented. It consists of an ionization chamber containing a first electrode supporting a long half-life radioactive source, a collector electrode divided into several insulated fractions, which possesses a symmetry of revolution and is coaxially positioned with respect to the first electrode, a highly insulated selector enabling one or several fractions of the collector electrode to be connected to a current output, and a power supply, which maintains a pd between the first electrode and the fractions of the collector electrode connected to the output. This source consists of a thin layer having a symmetry of revolution and containing a radioisotope emitting in the direction of the second electrode. (France)

7702 LOW CURRENT GENERATORS. Dalmazzone, J. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods; 105: No. 2, 237-44(1972). (In French).

Low current generators are described which have been built to check the fidelity and reproducibility of current measurement devices using ionisation chambers. The principle of these generators is a combination of an ionisation chamber with a convenient radioactive emitter. Two types of apparatus have been built. First, so called "simple" generators able to deliver one of the following intensities: 10^{-10} A ± 0.5%, 10^{-11} A ± 0.3%, 10^{-12} A ± 0.7%, 10^{-13} A ± 2.6%. Secondly, a "multigenerator", this last being able to deliver the following three intensities: 10^{-10} A ± 0.5%, 10^{-11} A ± 1%, 10^{-12} ± 2.1%. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

7703 DEVICE FOR THE ELUTION OF A RADIONUCLIDE DAUGHTER. Montgomery, J. R.; Struttman, L. G. (to Mallinckrodt Chemical Works). German Patent 1,959,586. 3 Feb 1972. (In German).

A radioisotope generator which contains the radioactive parent compound from which the daughter nuclide can be eluted is described. The container for the eluting agent, the ducts through the system as well as the container for the elute are arranged so as to guarantee simple and safe handling. The closed system brings about an important improvement, as compared with the hitherto known radioisotope generators which are applied in nuclear medicine, especially with regard to the radiation shielding. (GF)

7704 PROCESS FOR ENRICHMENT BY COUNTER-CURRENT MASS TRANSFER. Thayer, V. R. U. S. Patent 3,692,477. 19 Sep 1972. Filed 4 Aug 1969.

A chemical compound, element or isotope of an element is concentrated or enriched by physical or chemical exchange between two fluids passing countercurrently to each other in a plurality of concentrating units (vessels or towers). Each of the vessels is capable of operating independently. A feed fluid is supplied simultaneously to each of the units which concentrate and enrich it. The degree of enrichment occurring in a particular vessel depends upon the physical length of the particular vessel. The enriched products produced in the shorter vessels are fed, in contradistinction to prior art processes, to the longer vessels for further concentration. The process may be operated continuously regardless of the shutdown of one or more of the individual vessels utilized in the process. (Official Gazette)

7705 DEVELOPMENT OF ^{235}U IMPORT INTO THE COUNTRIES OF THE EUROPEAN COMMUNITY FROM 1966 THROUGH 1971. Atomwirt., Atomtech.; 17: No. 12, 636-7(Dec 1972). (In German).

The statistical bureau of the European Community publishes a systematic compilation of fissionable material import. In 1971, West Germany imported 106.8 kg plutonium for research purposes. Import of enriched uranium into the countries increased in 1971 up to 10.576 kg ^{235}U. The imports are tabulated for the years 1966 through 1971 and are specified with respect to degree of enrichment, amount of uranium, amount of ^{235}U for West Germany, France, Italy, Holland, and Belgium. (H.B.G.)

Isotopic Power Sources

Refer also to abstracts 7708 and 7816.

7706 IMPLANTABLE NUCLEAR-FUELED CIRCULATORY SUPPORT SYSTEM. I. SYSTEMS ANALYSIS OF CONCEPTION, DESIGN, FABRICATION, AND INITIAL IN VIVO TESTING. Norman, J. C. (Harvard Medical School, Boston); Molokhia, F. A.; Harmison, L. T.; Whalen, R. L.; Huffman, F. N. Ann. Surg.; 176: No. 4, 492-502(Oct 1972).

The design, implantation procedures, and in vivo testing of a nuclear-powered left ventricular assist device (LVAD) are described. It consists of two modules: the Model VIII pump, accepting blood from the left ventricular apex and ejecting it into the descending thoracic aorta, positioned on the left hemidiaphragm; and a power source (consisting of the ^{238}Pu fuel capsule, Tidal Regenerator Engine, thermoelectric module, and electronic logic) suspended from the left psoas tendon, retroperitoneally. The pumping chamber has a Dacron flocked surface with inlet and outlet tricuspid valves. It also serves as a blood-cooled heat exchanger and a position sensor for the control logic. The LVAD is hydraulically driven by a high pressure output of the engine (up to 1/100 hp). The engine is electronically controlled and converts the heat of decay of 120 g of ^{238}Pu (52 thermal watts) into hydraulic power for driving the blood pump. The blood pumping power is about 10,000 times that required to drive a pacemaker. The engine vaporization requires only 1 drop (0.015 ml) of water. Electrical power to control the engine is obtained by thermoelectric conversion. The $T_{1/2}$ of the fuel is 89.0 years. The projected design life of the system is 10 y. The engine operating temperature is 900°F. During the first in vivo 8-h test the left ventricular assist device stroke volume was 100 ml/beat and the calf's rectal temperature was 98°F. (T.F.D.)

7707 MULTI-HUNDRED WATT HEAT SOURCE. (Engineering Materials). (Monsanto Research Corp., Everett, MA. Boston Labs.). (CAPE-2299).

1 drawing.

Radiation Sources

Refer also to abstracts 7495 and 7952.

7708 (PAEC(A)-727) ^{60}Co. A Literature Search. (Philippine Atomic Energy Commission, Manila). Jan 1972. 241p. Dep. NTIS (U. S. Sales Only).

A bibliography of 1411 references is presented. The bibliography is divided into sections on chemistry, earth sciences, engineering, instrumentation, materials, physics, and reactor technology. The references were obtained by a search of Nuclear Science Abstracts covering the period July 1955 to July 1970. (J.R.D.)

7709 USE OF MIXED SOURCES IN X-RADIOMETRIC ANALYSIS. Baldin, S. A.; Dolenko, A. V.; Ioannesyants, L. M. Yadern. Priborostr.; No. 13, 38-41(1970). (In Russian).

The sensitivity and rapidity of x-radiometric analysis on many elements is limited at the present by the absence of radioactive sources whose γ energy is optimum for the excitation of the x-ray characteristic radiation of the desired element. The possibility of using mixed sources for this purpose is examined. The radiation spectrum and the results of measurements for analysis of tin are given. (tr-auth)

7710 PREPARATION OF ^{241}Am SOURCES BY SURFACE ADSORPTION ON DIFFERENT BACKINGS. Bellemare, M.; Lachance, Y.; Roy, J. C. (Univ. Laval, Quebec). Nucl. Instrum. Methods; 104: No. 3, 615-17(1972).

The uniformity of radioactive sources can be greatly improved by partial evaporation or complete evaporation of the solution followed by a washing of the deposit. The technique has been applied to the preparation of ^{241}Am sources on different backings. The improvement in source homogeneity is associated with the adsorbing power of the backing. Silicon monoxide coated backings give the best results. (auth)

7711 KIT FOR THE PRODUCTION AND FAST ISOLATION OF MEDICALLY USEFUL ^{18}F. Scholz, K. L.; Sodd, V. J. (Univ. of Cincinnati). Int. J. Appl. Radiat. Isotop.; 23: No. 10, 465-8 (Oct 1972).

A simple kit-method for the reactor production of medically useful ^{18}F is described. The ^{18}F is collected from acid solution on hydrous zirconium oxide, eluted with dilute base, and prepared for injection. The chemical yield of the 30-min procedure is 80%. About 4 mCi of ^{18}F per gram of 95% enriched $^{6}Li_2CO_3$ can be delivered 3 h (transportation and separation time) after the end of a 4-h irradiation in a neutron flux of 1.5×10^{13} cm^{-2} sec^{-1}. The tritium content of the final product is 2 to 3% corrected to the end of the irradiation. Other radioactive impurities such as ^{24}Na and ^{42}K are less than 0.001%. Repeated tests have shown the ^{18}F product to be sterile and non-pyrogenic. (auth)

Design and Fabrication

7712 ENCLOSURE WITH RADIATION SOURCE HAVING FAIL SAFE SHUTTER. Boissevain, M. G.; Hill, R. C. (to Measurex Corp.). U. S. Patent 3,697,755. 10 Oct 1972. Filed 17 Jan 1969.

An enclosure for a radiation source having a fail-safe shutter means is described. The shutter is urged to the closed position by springs and is moved to an open position by energization of a rotary solenoid. (T.F.D.)

Industrial Uses

7713 (RISO-M-1523) PERFORMANCE TEST OF WOOD-PLASTIC PARQUET FLOORING. Singer, K.; Vinther, A. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug 1972. 34p. Dep. NTIS (U. S. Sales Only).

Wood-plastic combinations made into parquet flooring were tested in the entrance part of the canteen at the Research Establishment Risoe, which is daily visited by about 700 people. The investigation included two wood species, namely ash and maple, impregnated with the following types of vinyl monomer systems: methylmethacrylate, styrene/acrylonitrile, unsaturated poly-

ester/styrene, and an acrylic prepolymer/monomer mixture. The curing was performed by cobalt-60 gamma radiation and by electron accelerator irradiation. Physical measurements are not included. The investigation was based solely on visual observations. (T.F.D.)

7714 PRIMENENIE IZOTOPOV NA NEFTYANYKH PROMYSLAKH. (Use of Isotopes in Oil Fields). Sokolovskii, E. V.; Zaitsev, V. M. Moscow; Izdatel'stvo Nedra (1971). 160p.

The choices of radioisotopes for labelling liquids and gases are discussed in detail. The uses of such indicators in water-flooding strata, in investigation of deposits in a number of specific geological areas, in labelling gases in rock seams, and in determining the mobility of residual pools of water and the leakage in underground reservoirs are discussed. A considerable amount of experimental data is presented and evaluated. 34 references, 24 of which are in English. (K.S.W.)

7715 IRRADIATION TREATMENT OF BACON WITH GAMMA RADIATION. Kosaka, K. (Japan Meat Processors Association, Tokyo); Ozawa, S.; Danbara, H. Nippon Shokuhin Kogyo Gakkaishi; 18: No. 6, 264-71(Jun 1971). (In Japanese).

Optimum radiation doses for the preservation of bacon for one month of shelf life at room temperature was investigated by irradiation with 0.00, 0.25, 0.50, 0.75, and 1.00 Mrad of gamma rays, respectively. The samples irradiated with less than 0.75 Mrad were not kept even for one month. Even in the case of 1.00 Mrad sample, 10^6/g survivors were detected, indicating that it was not in good hygienic condition for food. Bacon samples irradiated with low doses (0.5 Mrad) and high doses (5.0 Mrad) were compared. The high-dose sample kept well apparently much longer. The off-flavor decreased gradually during the storage period, and disappeared in one month when the bacon was cooked. The low-dose sample was not kept for one month. In another experiment, 1, 3, and 5 Mrad of irradiation were compared. After 45 days of irradiation, there were only a few survivors (10^3/g) detected in the samples irradiated with 3 and 5 Mrad at 15°C. Considerable off-flavor appeared in 5 Mrad samples. A little off-flavor appeared in 3 Mrad samples, which disappeared about one month after irradiation. From these results, it was considered that the optimum dose of irradiation of bacon is 3.0 Mrad. (auth)

7716 APPLICATION OF POWERFUL RADIATION SOURCES IN CHEMICAL AND PLASTIC INDUSTRIES. Hoigne, J. Chimia (Aarau); 26: No. 10, 542-6(10 Oct 1972). (In German).

Radiation installations and radiation effects are discussed. Radiation-initiated chemical reactions are then considered from an economical standpoint. As practical examples, the analysis focusses on hardening of lacquers, impregnation of cotton, and vulcanization of rubber. Other types of polymerization are considered with respect to: polyethylene, PVC, grafting of monomers on polymers, surface improvement of foils and plastic parts, emulsion polymerization, and polymerization after impregnation. Also discussed is radiation sterilization of material. (H.B.G.)

LIFE SCIENCES

7717 PROCEEDINGS OF THE MEDICAL AND BIOLOGICAL PHYSICS DIVISION, CANADIAN ASSOCIATION OF PHYSICISTS ANNUAL MEETING. Phys. Med. Biol.; 17: No. 6, 884-90(Nov 1972).

Abstracts are presented of papers read at a 4 day meeting. Papers included those in the following subjects: (1) EPR studies of Cu^{2+} complexes in glycine, serine, and lycine compounds, (2) Biological radiation effects on immune responses, mammalian intestines, and on growth of cells maintained on irradiated media, (3) Proportional wire chambers for imaging x rays for medical diagnostics, (4) Dosimetry of γ rays, fast neutrons, negative π-mesons, ^{137}Cs linear γ sources, and isodose mapping of radiation dose distribution in mantle therapy of Hodgkin's disease. (UK)

Radiation Effects on Biochemicals

7718 (COO-3482-5) KINETICS OF STRAND REJOINING IN WILD-TYPE MICROCOCCUS RADIODURANS AND A RADIATION SENSITIVE MUTANT UV17. Bonura, T.; Bruce, A. K. (State Univ. of New York, Buffalo). 1972. 8p. (CONF-720461-1). Dep. NTIS.

From 72nd annual meeting of the American Society for Microbiology; Philadelphia, PA. (23 Apr 1972).

The strand rejoining and DNA breakdown kinetics of Micrococcus radiodurans (wild-type) and a radiation sensitive mutant (UV17) have been studied. Alkaline sucrose gradient analysis of DNA during post x-ray incubation demonstrates an extremely rapid restitution of strand breaks in wild-type cells. This rapid rejoining is followed by a much slower rejoining after 5 to 15 min. UV17 does not exhibit this extremely rapid component, its kinetics of rejoining being described by two components both of which are far less rapid than fast repair in wild-type cells. DNA degradation in wild-type cells during the fast reaction is neither faster nor more extensive than during the remainder of the repair interval. The results suggest that, in the fast reaction, either a DNA ligase-like step or an extremely efficient repair replication is responsible in which only a few bases are excised and repaired per break. In either case it appears that UV17 is either deficient or severely limited in this mode of repair. (auth)

7719 EFFECTS OF COMBINED HEAT AND IRRADIATION TREATMENT ON PECTIN METHYLESTERASE. Delincee, H. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Confructa; 15: No. 6, 366-75(1970).

The inactivation of pectin methylesterase was examined with combined heat and irradiation treatment. In phosphate buffer solution, by heating after pre-irradiation and by irradiation after pre-heating synergistic effects were observed, the former method being the most effective. With simultaneous heating and irradiation treatment, a strong synergistic effect could be seen, where the degree of inactivation with increasing temperature was much greater than the sum of the separate degrees of inactivation due to heat and to irradiation. In phosphate-citrate buffer solution the degree of inactivation reached was considerably lower than that in phosphate buffer solution, which is probably due to the protective effect of the citrate. In the case of combined heat and irradiation treatments in citrate buffer solution a synergistic effect was also observed. With orange juice, irradiation at 0°C with a dose up to 1 m rad (1,000 krad) no inactivation of the pectin methylesterase could be seen. Only at the highest experimental temperature (62.50°C) using simultaneous heat and irradiation treatment, a small synergistic effect was detected. (GF)

7720 PHOTOCHEMICAL REACTIONS OF 1,3-DIMETHYLURACIL WITH 1-AMINOPROPANE AND POLY-L-LYSINE. Gorelic, L. S.; Lisagor, P.; Yang, N. C. (Univ. of Chicago). Photochem. Photobiol.; 16: No. 6, 465-80(Dec 1972).

Irradiation of 1,3-dimethyluracil (DMU) in 1-aminopropane (AP) with uv light resulted in the formation of reduced and dimeric forms of DMU and AP. The formation of these compounds could be rationalized from the activation of either DMU or AP. Irradiation of DMU and poly-L-lysine in water with uv light resulted in the extensive binding of DMU to poly-L-lysine. It was suggested that the pyrimidine is probably attached to the ϵ-carbon of the polypeptide at the 6-position. The biological implications of these studies are discussed. (auth)

7721 RADIATION-INDUCED STRAND BREAKAGE IN MAMMALIAN CELL DNA. 1. ENHANCEMENT OF SINGLE-STRAND BREAKS BY CHEMICAL RADIOSENSITIZERS. Dugle, D. L.; Chapman, J. D.; Gillespie, C. J.; (and others) (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Int. J. Radiat. Biol.; 22: No. 6, 545-55(Dec 1972).

Chinese hamster cells irradiated with x rays in complete medium while attached to glass surfaces and equilibrated with either air or nitrogen have been subsequently assayed for both colony-forming ability and size distribution of single-strand DNA fragments. Compounds evaluated for their ability to radiosensitize hypoxic cells and the concentrations used were: 1 mM para-nitroacetophenone (PNAP), 500μM N-(5-nitro-2-furfurylidine) 1-aminohydantoin (nitrofurantoin or NF2), 500μM 5-nitrofuraldehyde-2-semicarbazone (nitrofurazone or NF1), and 500μM 5-nitrofuraldehyde-2-oxime (nifuroxime or NF3), D_0 values of 323, 227, 179, 155, 160, and 105 rads were obtained for N_2, N_2 + 1 mM PNAP, N_2 + 500μM NF2, N_2 + 500μM NF1, N_2 + 500μM NF3, and air, respectively, which give enhancement ratios [ER(Survival)] of 1.00, 1.45, 1.80, 2.09, 2.01 and 3.08, respectively, for these conditions. The values of electron volt/single-strand break determined from alkaline sucrose sedimentation analyses for N_2, N_2 + 1 mM PNAP, N_2 + 500μM NF2, N_2 + 500μM NF1, N_2 + 500μM NF3 and air were 284, 155, 109, 92, 82 and 83 which give enhancement ratios [ER(ev/SSB)] of 1.00, 1.83, 2.61, 3.08, 3.47 and 3.44 respectively. These data show that, within experimental error, the relative effectiveness of these compounds and molecular 0_2 as radiosensitizers of strand breakage in DNA of Chinese hamster cells is reflected at the level of cell survival. (auth)

7722 FURTHER DATA ON DNA STRAND BREAKAGE BY VARIOUS RADIATION QUALITIES. Neary, G. J.; Horgan, V. J.; Bance, D. A.; Stretch, A. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol.; 22: No. 6, 525-37(Dec 1972).

Thin films of dry DNA (~ 30 per cent water content) from T7 bacteriophage were irradiated by charged particles with track segment LET values up to 255 keV/μm. Mean numbers of single- and double-strand breaks per molecule were determined by boundary sedimentation in an analytical ultracentrifuge. For both types of break, the number per unit dose increased only slightly up to about LET_∞ = 100 keV/μm, but more rapidly beyond that point; the ratio of the numbers of the two types of breaks did not change systematically throughout the whole range of LET_∞. The data have been analyzed to deduce the separate contributions of the primary track cores and the delta-rays to total dose and to total single- or double-strand breakage. Breakage by the primary cores per unit dose from cores began to increase markedly above a core LET_{100} around 50 keV/μm. The increase could be explained by effective cooperation between two or more events of small size occurring together at high LET but which would be rather ineffective when occurring singly at low LET. On the basis of estimates of core diameters currently adopted in radiation chemistry, it appeared that one intersection of the DNA molecule by a core with high LET_{100} produced several single-strand breaks, implying long-range intramolecular transfer of energy. This conclusion could be avoided by postulating that core diameters are larger by an order of magnitude than the presently accepted values. (auth)

7723 HOST-CELL REACTIVATION OF Φ X174 RF-DNA DAMAGED BY γ-RAY-INDUCED PHENYLALANINE AND WATER-RADICALS. de Jong, J.; Loman, H.; Blok, J. (Vrije Univ., Amsterdam). Int. J. Radiat. Biol.; 22: No. 6, 579-87(Dec 1972).

Aqueous solutions of the double-stranded form of Φ X174 DNA have been irradiated with γ-rays in the presence of phenylalanine. Evidence is presented showing that under these circumstances DNA inactivation is largely due to secondary amino acid radicals. It is suggested that such reactions of organic radicals might play a role in living cells. If the irradiation were carried out under N_2O, the apparent sensitivity of the DNA was markedly increased by testing its virus-inducing capacity on spheroplasts prepared from Uvr^- strains of Escherichia coli. Such a difference in survival on Uvr^- and Uvr^+ spheroplasts was not found in the presence of oxygen, nor did it occur after irradiation in the absence of the amino acid. Testing of irradiated DNA on spheroplasts of a Pol^- strain resulted in a somewhat increased apparent radiosensitivity in the presence, but also in the absence of phenylalanine. This effect was not suppressed by irradiation under oxygen. (auth)

7724 FIZIKOKHIMIYA LUCHEVOGO PORAZHENIYA. (Physicochemistry of Radiation Damage). Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). 142p.

Separate abstracts were prepared for the 10 papers appearing in this publication. (E.R.B)

For abstracts of individual chapters see: 7725-7727, 7735, 7736, and 7776-7780.

7725 FREE-RADICAL PROCESSES IN IRRADIATED BIOLOGICAL SYSTEMS. Kozlov, Yu. P. (Moscow State Univ.).

pp 30-46 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

Application of the graft copolymerization and chemiluminescence methods to a study of the free-radical processes in various animal and plant tissue homogenates exposed to 600 to 1500 R doses of gamma radiation. The substantial role of free-radical states, notably lipids and their complexes, in the mechanism of the radiation damage sustained by irradiated biological materials is discussed. (IAA)

7726 EFFECT OF SEPARATE IRRADIATION OF THE ENZYME AND THE SUBSTRATE ON THE DYNAMICS OF PROTEOLYSIS. Lomsadze, B. A. (Moscow State Univ.). pp 99-109 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

A study was made of postirradiation changes in the proteolytic activity of cathepsin C (prepared according to Dela Haba et al. (1955)), trypsin, and cysteine in four series of experiments on hemoglobin-albumin-globulin substrates, with the enzyme and substrate components unexposed or separately exposed to gamma radiation doses from 150 to 200 kR. It is found that the proteolysis of serum albumin by trypsin was stimulated markedly after irradiation of both the trypsin and the albumin. The stimulating effect is linked to radiation-induced changes in proteins. (IAA)

7727 ANTIOXIDATIVE ACTIVITY OF LIPIDS IN RADIATION LESIONS. Tarusov, B. N. (Moscow State Univ.). pp 110-14 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

A study was made of free-radical oxidation reactions in the lipid elements of cells from the blood, liver, spleen, brain, and intestines of rats exposed (from 4 to 240 hr) to 650 and 1500 R doses of ionizing radiation. The intensity of the extinction of the anodic chemiluminescence of a carbon tetrachloride–methanol–ethanol mixture by samples of irradiated tissues is used as a criterion of lipid antioxidative activity. A depression of the antioxidative activity is observed in irradiated cells from the liver, spleen, and intestines. (IAA)

Radiation Effects on Cells

Refer also to abstracts 7628 and 7753.

7728 (INIS-mf-289, pp 11) SISTER CHROMATID EXCHANGER IN CHROMOSOMES OF THE SWAMP WALLABY (WALLABIA BICOLOR) DERIVED FROM LEUKOCYTE CULTURES. Geard, C. R. (Australian National Univ., Canberra). 1972. (CONF-720334-2). INIS.

From fourth human cytogenetics conference; Melbourne, Australia (7 Mar 1972).

Tritiated thymidine was made available to stimulated peripheral leukocytes of the swamp wallaby (Wallabia bicolor). Metaphase chromosomes were examined at the second and third cell cycles following the incorporation of label and sister chromatid exchanges were recorded on an individual chromosome basis. Analysis of the data showed that the frequency of exchanges per chromosome is closely proportional to chromosome length, and exchanges per chromosome are not significantly reduced from division to division. This data is interpreted as meaning that, if visible sites of exchange are restricted, then the frequency of sister chromatid exchanges is constant from division to division. This would not be expected if sister chromatid exchanges are induced by radiation from the incorporated tritium, since tritium induced chromatid aberrations do decrease from division to division. Therefore confirmation of the results from the human ring data is not provided. (INIS)

7729 SPECIFICITY OF THE GENETIC EFFECT OF INTERMEDIATE-ENERGY NEUTRONS IN THE IRRADIATION OF HUMAN PERIPHERAL BLOOD LYMPHOCYTES (IN VITRO). Arsen'eva, M. A.; Troitskii, N. A.; Golovkina, A. V.; Elisova, T. V.; Sokolov, N. N. (Inst. of Biological Development, Moscow). Dokl. Akad. Nauk SSSR; 204: No. 5, 1243-5(11 Jun 1972). (In Russian).

Preliminary data were obtained on the yield of chromosome aberrations of various types in the lymphocytes of human blood in vitro during irradiation with x rays and 1.7 to 0.2 MeV neutrons. With fast neutrons, the yield of aberrations of the chromatid type was small, but the frequency of exchange chromosomal reorganizations increased linearly with increased dose. With intermediate neutrons, qualitatively different results were obtained; larger doses resulted in an exponential reduction of chromosomal aberrations. The use of x rays produced a distribution of chromosomal aberration types similar to that from fast neutrons. (K.S.W.)

7730 COMPOUND FOR TREATING RADIATION DAMAGE AND PROCEDURE FOR ITS PREPARATION. Sekiguchi, Toyozo; Fujii, Tomio; Kobayashi, Hideo (to Kakenyaku Kako Kabushiki Kaisha). German Patent 2,026,712. 9 Mar 1972. (In German).

The present patent claims are based on, first, a compound consisting of basic polyamine and DNA for the treatment of radiation damage and, second, on a method for the preparation of a compound for the treatment or prevention of radiation damage from DNA and basic amine, or basic amino acid, characterized in that DNA and basic amine, or basic amino acid, are dissolved separately either in diluted sodium chloride solution, or else in a sodium chloride solution containing sodium acetate, with the solutions thus obtained being put together for reaction, upon which the reaction mixture is allowed to settle for 6 to 36 hr at at 37°C; its pH value is then fixed to 7 and, after an admixture of alcohol, the precipitation thus obtained is centrifuged. The therapeutical effect on radiation damage of the products prepared according to the invention has been verified by two different ways. The first method was to irradiate Changs' liver cells with x rays and to determine the increase in the number of colonies in the samples treated with the compound, and to compare the values with those of control samples. The second verification consisted of an animal experiment, with the compound prepared according to the invention being administered by i.p. injection into mice subsequent to whole-body irradiation with x rays. (GF)

7731 EFFECTS OF INTERCELLULAR CONTACT ON REPAIR OF RADIATION DAMAGE. Durand, R. E.; Sutherland, R. M. (Ontario Cancer Treatment and Research Foundation, London). Exp. Cell Res.; 71: No. 1, 75-80(Mar 1972).

Chinese hamster cells in exponential growth as multicellular spheroids were more resistant to radiation damage than were single cells. The survival curve for cells grown and irradiated as spheroids was characterized by a wider shoulder, suggesting enhanced capacity for repair of sublethal damage. This increased repair capacity was developed inherently by cells grown in contact, and was increased further if cells remained in contact during irradiation. (auth)

7732 RADIOSENSITIZATION BY NIFUROXIME OF THE HYPOXIC CELLS IN AN IN VITRO TUMOUR MODEL. Sutherland, R. M.; Durand, R. E. (Ontario Cancer Treatment and Research Foundation, London). Int. J. Radiat. Biol.; 22: No. 6, 613-18(Dec 1972).

The ability of nifuroxime (anti-5-nitro-2-furaldoxime) to radiosensitize hypoxic cells was studied in spheroids (300 to 400μ dia.) of Chinese-hamster V79-171B lung cells. Results of the first set of experiments showed the effects of treatment with nifuroxime on spheroid cell plating effeciency after 1400 rads. No significant toxicity was produced up to 1 hr, but the plating efficiency was reduced from 60% in untreated spheroids to approximately 50, 45, and 25% after 3 hr in contact with 0.25, 0.5, and 1 mM nifuroxime respectively. Sensitization increased with concentration and duration of pretreatment except with 0.25 mM where maximum sensitization was seen at 75 min. At 1 mM pretreatment for periods longer than 1 hr, the sensitized survival was less than that for reoxygenated cells. From these experiments survival curves were produced. With pretreatment at 1 mM furoxime for 2 hr, the final solpe (Do) from the curve of unsensitized control spheriods was 240 rads, compared with 180 and 100 rads for the reoxygenated and sensitized spheriods. There were toxic conditions causing a decrease of plating efficiency from 60 to 40%. Pretreatment of spheroids with 0.5 mM for 20 min caused no toxicity and decreased the terminal Do to 160 rads. The difficulties in interpreting these results are discussed in relation to the variations in radiosensitivity shown during the cell cycle. (UK)

7733 VARIATIONS, AS A FUNCTION OF CELL CYCLE, OF MITOTIC DELAY INDUCED BY IRRADIATION OF BHK 21 CULTURES. Lafontaine, N.; Firket, H. (Univ., Liege). Int. J. Radiat. Biol.; 22: No. 6, 607-11(Dec 1972). (In French).

Fibroblast cultures of the BHK 21-C 13 line were synchronized by concentrated thymidine treatment. After return to normal medium, a very large proportion of the cells were in S phase and later, from the 3rd to the 5th hr, a definite majority of the cells were in G_2. A mitotic wave followed (peak at 6th hr). These cultures were γ-irradiated with 450 and 900 R at different times between the end of the thymidine treatment and the 5th hr. The mitotic delay was measured in each case. At both levels of irradiation, this delay was longest at the end of the S phase. If irradiation occurred during G_2, it was notably decreased. These results

are compared with others on different cell-lines and their significance discussed. (auth)

7734 EFFECT OF HYPERTONIC SHOCK ON THE RADIATION RESPONSE OF HeLa-3 CELLS. Malone, J. F.; Foster, C. J. (Dept. of Clinical Physics and Bio-Engineering, Glasgow). Int. J. Radiat. Biol.; 22: No. 6, 599-605(Dec 1972).

Hypertonic shock caused by sucrose-enriched medium reduced the extrapolation number and D_0 of the HeLa S-3 survival curve. The D_0 change persisted for some time after hypertonic shock, but the extrapolation number recovered with kinetics similar to x-ray recovery from radiation damage. A reciprocal effect of x-radiation on the sensitivity of cells to hypertonic shock was observed. (auth)

7735 MECHANISM OF THE PROTECTIVE ACTION OF PYRIDINE DERIVATIVES. Burlakova, E. V.; Burdin, K. S.; Parkhomenko, I. M.; Afonin, V. I. (Moscow State Univ.). pp 12-20 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

Studies were made of the radioprotective action of AET, pyridine, vinyl pyridine, copper and cobalt thiopicoline anidine chelates, thiopicoline anisidine, cobalt thiopicoline anisidine chelate, copper alpha-methylthiopicolinetoluidine chelate, mannitol, and vinyl pyrrolidone in cells from the heart of a monkey and in embryonic cells of the human epithelium exposed to 320, 480, 640, and 800 R doses of gamma radiation. The antioxidation action of these compounds is evaluated by using the dioxyphenyl alpha-alanine oxidation reaction. Hypothetical mechanisms of the radioprotective action of these agents are discussed. (IAA)

7736 PHOTODYNAMIC DAMAGE IN CELLS AND THEIR PROTECTION. Parkhomenko, I. P.; Sverdlova, L. A.; Zakirov, L. A. (Moscow State Univ.). pp 47-59 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

A review is presented of published studies concerning the nature of damage caused by light in biological cells, discussing possible approaches to damage prevention. Special attention is given to free-radical processes as damage originators. The protective action of thiourea against photodynamic hemolysis is considered, along with that of mono- and polyvinylpyrrolidone, cysteine, and a group of antibiotics. An inhibitive effect on photodynamic damage is established in neomycin, oleandomycin, erythromycin, and polymyxin. (IAA)

Radiation Effects on Microorganisms

Refer also to abstract 7778.

7737 (AD-745104) X-IRRADIATION SCHEDULES FOR SELECTED RESPONSES IN YEAST. Final Report. Spoerl, E. (Army Medical Research Lab., Fort Knox, Ky.). 29 Feb 1972. 18p. (USAMRL-967). NTIS.

Yeast cultures x-irradiated continuously during two or three cell generations compared with cultures given short-period irradiations at high dose-rate exhibited differences in division rate, cell number, cell size, and viability. These differences indicate that modifications in irradiation procedures can be useful in obtaining responses selected to promote the identification of affected reactions. Continuous irradiations suppressed cell division more consistently, produced populations more uniform in size, and when appropriately terminated, allowed the cells to divide in synchrony, presumably because an essential reaction (s) involved in division was selectively affected. (auth) (GRA)

7738 EVIDENCE FOR A FURTHER DARK REPAIR PROCESS IN BACTERIA. Bridges, B. A. (Univ. of Sussex, Brighton, Eng.). Nature (London) New Biol.; 240: No. 97, 52-3(8 Nov 1972).

The literature is reviewed and a brief summary presented of the evidence for the existence of a third DNA dark repair process for ultraviolet damage known as reinitiation recovery. It is suggested that it involves the repair and removal of a stalled replication point and the initiation of a new one at the chromosomal origin; that it is inhibited by chloramphenicol and acriflavine; that it is dependent upon both recombination and excision functions; and that it is responsible for the shoulders on some ultraviolet survival curves. Examples are taken from studies of Escherichia coli. (UK)

7739 DIRECT INDUCTION IN WILD-TYPE NEUROSPORA CRASSA OF MUTANTS (qa-1^c) CONSTITUTIVE FOR THE CATABOLISM OF QUINATE AND SHIKIMATE. Partridge, C. W. H.; Case, M. E.; Giles, N. H. (Yale Univ., New Haven). Contract AT(30-1)-3098. Genetics; 72: No. 3, 411-17(Nov 1972).

A color test was developed for the selection and identification of mutants in Neurospora crassa, constitutive for the three normally inducible enzymes that convert quinate to protocatechuate. By this means, seven such mutants were recovered after uv irradiation of wild type and were shown to be allelic (or very closely linked) to the qa-1^c mutants previously obtained by other means. Thus, the regulation of the synthesis of these three catabolic enzymes is indicated to be under the control of a single gene, qa-1$^+$. (auth)

7740 STUDIES ON THE STRUCTUREDNESS OF CYTOPLASM AND RATES OF ENZYMATIC HYDROLYSIS IN GROWING YEAST CELLS. 2. CHANGES INDUCED BY ULTRA-VIOLET LIGHT. Cercek, Lea; Cercek, B. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 22: No. 6, 539-44(Dec 1972).

Changes in the structure of cytoplasm after irradiation with uv-light under oxic and hypoxic conditions in yeast cells (Saccharomyces cerevisiae) were studied. These were followed by measuring the fluorescence polarization of fluorescein molecule produced by enzymatic hydrolysis of the fluoresceindiacetate (FDA) in the cytoplasm of cells in logarithmic growth. Concomitant changes in the rates of enzymatic hydrolysis of FDA to fluorescein in vivo were measured. Mechanisms for the photolytic changes in the structuredness of the cytoplasm and in the rates of enzymatic hydrolysis of FDA are discussed. (auth)

Radiation Effects on Plants

7741 RADIATION INDUCED VARIABILITY IN IMPROVEMENT OF BROWN SARSON. Kumar, P. R. (Banaras Hindu Univ., India). Radiat. Bot.; 12: No. 5, 309-13(Oct 1972).

A study was undertaken to improve the flowering time and the number of seeds per siliqua in highly cross pollinated Brassica campestris L. var dichotoma Watt (cv. brown sarson). Dry seeds of three strains of cultivar brown sarson were exposed to varying doses of gamma rays and thermal neutrons over a range 0 to 100 Krad and grown from 1965 to 1969. The pattern of release of polygenic variability and the degree of shifts in mean values were examined in terms of range, coefficient of variation, and the mean from the M_2 to M_4 generation. Selection was practiced in M_3 plants that were at least 10 days earlier in first flowering and with a minimum of 20 seeds per siliqua. The selected genotypes were permitted to intercross in isolations in the M_4 generation. The specific radiation treatments generated additional variability without altering the mean values of two traits in different generations. In the M_4 generation, a high degree of variability was released that afforded opportunity for stabilizing the mean values of these two polygenic traits of high economic value in the M_5 generation at a desired level. (auth)

7742 ACTION OF COMBINED X-RADIATIONS AND MAGNETIC FIELDS ON DRY SEEDS OF PISUM SATIVUM L. Corneanu, G. C.; Szekely, I. B. (Univ., Craiova, Rumania). Radiat. Bot.; 12: No. 5, 315-22(Oct 1972).

The single and combined action of x-rays (over a range 0 to 20 Krad) and of homogeneous magnetic fields on dry seeds of Pisum sativum L. var. melileucum was investigated. Dry pea seeds (3.3% moisture content) treated with x rays and with homogeneous magnetic field (100 or 180 Oe for 30 mins), singly or combined, were observed for several effects during the development of the plants. In the first stages of growth (48 hr after germination), with combined treatment the magnetic field increased the effect caused by x-rays alone at low exposure, but decreased effect at high exposure. But these changes were proved to be short-term and reversible; at later growth times, the action of the magnetic field on the radiation damage was much less. Ten-day seedling height was about the same, and number of plants surviving to maturity did not differ significantly between combined treatment and the x-rays alone. The changes of the first stages of growth were considered to be due to physiological changes stressed by the meristematic proteins with different iso-electric point, perhaps because of the formation of chelate compound complexes between meristematic proteins and the micro-elements susceptible magnetically. (auth)

7743 RELATIVE MERITS OF THE THREE METHODS OF MEASURING MUTATION FREQUENCY IN BARLEY. Mohan Rao, P. K. (Univ. of Malaya, Kuala Lampur). Radiat. Bot.; 12: No. 5, 323-9(Oct 1972).

Chlorophyll mutation frequency induced by single treatments with radiation (x- or γ-rays over a dose range 0 to 60 KR) and diethyl sulfate (dES) and by pre- and post-radiation dES-treatments was analyzed using M_1-plant, M_1-spike, and M_2-seedling methods in

order to determine whether the mutagenic effects of radiation and dES combined additively or nonadditively in combination treatments. The type and magnitude of the apparent combination effect (the deviation of the mutation frequency shown by combination treatment from the mutation frequency expected on additive basis) depended on the method of mutation analysis and the severity of the combination treatment. This result was considered to be due to the existence of appreciable differences in the ability of the three methods to measure the true mutation frequency induced by mutagens. It was concluded that M_1-plant and M_1-spike methods grossly underestimate the induced mutation frequency, especially in severe mutagenic treatments. This tendency was attributed to the inability of these methods to account for the frequency of mutant initials in each spike primordium which, together with the frequency of spike primordia mutated, determines the total induced mutation frequency. The M_2-seedling method was considered to be superior to both M_1-plant and M_1-spike methods since it measures both the components of induced mutation frequency. (auth)

7744 EFFECTS OF GAMMA RADIATION ON LICHENS. I. ACUTE GAMMA RADIATION ON LICHEN ALGAE AND FUNGI. Gannutz, T. P. (Univ. of Connecticut, Storrs). Radiat. Bot.; 12: No. 5, 331-8(Oct 1972).

The effects of acute gamma irradiation over a dose range 0 to 100° KR on isolated cultures of lichen algae and fungi were determined quantitatively. Lichen algae were more radiosensitive than the lichen fungi, even among components from the same species of lichen. This was in direct correlation to the effects of natural environmental stress. Although the lichen fungi had similar radiosensitivities to similar free-living fungi, the irradiated lichen fungi were entirely in the vegetative state (i.e. not in stages of reproduction or sporulation) and it was apparent that the lichen fungi are less radiosensitive than similar free-living fungi. Radiosensitivities of lichen algae and free-living algae were similar. When comparisons were made with intact thalli growing in a chronically irradiated situation, it appeared that the intact thallus was more radiosensitive than either the algal or fungal component in culture. It is postulated that this is due to the addition of another stress (i.e. radiation) on an already strained symbiotic relationship. Correlations were attempted between the various species of algae and fungi, their radiosensitivities, and water, lipid, and DNA contents. (auth)

7745 RADIOSENSITIVITY OF SEEDS OF SOME NATURAL AND EXPERIMENTAL POTATO AUTOPOLYPLOIDS. Olimpienko, G. S.; Kurillovskaya, N. A.; Mitrofanov, Yu. A.; Volkova, R. I. Tsitol. Genet.; 6: No. 1, 57-63(Jan 1972). (In Russian).

The effect of 80 to 200 kR doses of γ radiation on seed of autopolyploid wild types of potatoes was studied in conjunction with their resistance to low temperatures. The viability of the seed after radiation indicated the degree of radiosensitivity. The level of cytogenetic damage in the anaphase and the number and size of interphase nuclei and of chromosomes in the cells obtained during germination were compared for irradiated and unirradiated seed. Dose curves of survival rate, being sigmoid, indicated the greatest radioresistance in the tetraploid form Solanum schreiteri, and the least in the hexaploidal S. demissum. The tetraploidal form S. punal occupied an intermediate position. Survival rate curves of experimental polyploids (radioresistance) were lower than those of tetraploids. A study of chromosomal aberrations in cells after irradiation of seed in 30 kR doses showed that the number of aberrant cells was the least for the tetraploid S. schreiteri, the greatest for the hexaploid S. demissum. Concerning the size of the interphase of the nucleus and chromosomes, neither one of the indicators, taken separately, could be used as a criterion of radioresistance. Natural and experimental polyploid forms of S. punal were characterized by the smallest nuclear dimensions, but possessed an advantage over the autopolyploid S. schreiteri in the matter of resistance to low temperature. (tr-auth) (INIS)

7746 EFFECT OF GAMMA IRRADIATION ON STRAWBERRY RUNNERS. Pandey, V. S.; Gupta, M. N. (Government Hill Fruit Research Station, Chaubattia, India). Indian J. Agr. Res.; 5: No. 1, 5-10(1971).

Strawberry cultivar runners were irradiated with different exposures i.e., 5, 10, and 15 KR of γ rays to determine the suitable exposure for induction of mutations. Observations were made on growth, flowering, and fruiting of M_1. A reduction of about 50% in fruit set per plant was recorded at 10 KR. Morphological abnormalities increased with increasing exposure and the yield decreased due to lower percentage of fruit set and smaller fruit size. Runners exposed to 15 KR showed 100% survival but their growth and yield were very poor. Some of the plants remained in vegetative stage while few produced malformed inflorescences. Runner formation started in all treatments from the first week of May. (Indian Sci. Abstr.)

7747 CHROMOSOME MUTATION YIELD FROM ^{137}Cs GAMMA IRRADIATION OF BARLEY SEEDS. Nuzhdin, N. I.; Dozortseva, R. L. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR; 204: No. 2, 461-4(11 May 1972). (In Russian).

Barley seeds were singly and fractionally irradiated with ^{137}Cs gamma radiation and allowed to germinate under different schedules. The number of chromosomal aberrations was greater in the case of singly-irradiated seeds than for seeds which had been fractionally irradiated. The data were further evaluated with respect to natural and forced dormancy. (K.S.W.)

7748 CHANGE IN ULTRAVIOLET FLUORESCENCE INTENSITY OF NUCLEI OF PLANT CELLS UNDER IRRADIATION AND TREATMENT OF PLANTS WITH GIBBERELLIN. Kryukova, L. M.; Nazarova, L. F. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR; 204: No. 2, 486-8(11 May 1972). (In Russian).

Roots of 4-day Russian black bean seedlings were subjected to irradiation from ^{137}Cs γ source, whereupon controls and experimental specimens were immediately treated with a solution of gibberellin (25 mg/l) for 10 hr. Different variants of this procedure were also utilized. Cells were stained with the fluorochrome acridine orange in order to determine differences in the intensity of uv fluorescence of the nucleic acids in the nuclei of growing cells. The fluorescence intensity of nuclei was greater for those plants that had received a 5 KR dose or had been treated with the extract from irradiated plants, in comparison with the controls. Gibberellin tended to restore the plants that were damaged by radiation, and also enhanced the intensity of the fluorescence of acridine orange-treated cells of the control plants. (K.S.W.)

Radiation Effects on Animals

Man

Refer also to abstracts 7498, 8878, 8880, and 8883.

7749 (ABCC-TR-35-71) STATURE OF ADULTS EXPOSED IN CHILDHOOD TO THE ATOMIC BOMBS OF HIROSHIMA AND NAGASAKI. Belsky, J. L.; Blot, W. J. (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 19 Nov 1971. 13p. (In Japanese and English). Dep. NTIS.

During the 5th Cycle of biennial examinations conducted at ABCC (1966 to 1968), height and weight measurements were obtained for approximately 3200 adult residents of Hiroshima and Nagasaki who were children under age 18 at the time of the atomic bombs of 1945 (ATB). The individuals in each city were classified according to sex, age, and estimated radiation dose. Analyses of the measurements found adult height to be significantly lowered among Hiroshima males and females exposed to high doses (100 + rad) of radiation when they were aged 0 to 5 yrs ATB; however, the effect of dose declined with increasing age ATB. No differences were noted among those aged 12 to 17 ATB. For Nagasaki, no statistically significant differences in means for height were noted by A-bomb dose group, although, for females who were 0 to 5 yrs ATB, the highest dose group had the smallest mean height. Weight was also lower for Hiroshima residents exposed in childhood to high doses. Smaller adult weights were evident for all ages, not only for those exposed while very young. No significant differences were seen in Nagasaki survivors. Nonradiation physical and psychological stresses that could affect growth are discussed. Still, it is concluded that a growth retarding effect of radiation can be demonstrated for the youngest heavily exposed children. Combined with prior observations at ABCC, a somatic effect due to exposure to high doses of A-bomb radiation is apparent from conception through early adolescence. The mechanism(s) for this is unknown. (auth)

7750 (AD-742837) COMPILATION OF NUCLEAR TEST FLASH BLINDNESS AND RETINAL BURN DATA AND ANALYTIC EXPRESSIONS FOR CALCULATING SAFE SEPARATION DISTANCES. Final Report, February 1970-April 1971. Shnider, R. W. (URS Research Co., San Mateo, Calif.). Apr 1971. Contract DASA01-70-C-0103. 60p. (URS-7011; DASA-2689). NTIS.

Characteristics of the human eye that affect the eye's sensitivity to thermal radiation, and potential protective measures are summarized. Nuclear bursts at which flash-blindness and retinal burn effects have been documented are identified, and the effects are reviewed and evaluated. Laboratory studies on flash-blindness are briefly reviewed, and wide variations are noted in individual recovery times from effects produced by the same source under the same conditions. Analytical equa-

tions derived from analysis of nuclear burst data are presented for calculating the following parameters of thermal radiation: (1) fireball radius as a function of time; (2) time to final thermal maximum, t_f, for air burst; (3) radiant exposure up to 10 t_f; (4) rate of thermal energy delivery as a function of time; (5) fraction of thermal energy delivered as a function of time; (6) rate of thermal energy delivery at time of first thermal maximum. Criteria based on nuclear test effects are evaluated for prevention of retinal burn. Separation distances, based on the criteria, and calculated by use of the analytical equations are presented graphically for the following conditions: safe viewing by unprotected dark-adapted subjects on the ground of only the first 100 msec of night bursts of yields of 1, 10, 45, 100, and 1000 kt at altitudes from 1 to 20 km; safe viewing for night-adapted visually unprotected subjects coaltitude with the same burst yields. Results are estimated accurate within 25 to 50%. (auth) (GRA)

7751 (AD-745084) METHOD FOR CALCULATING AIRCREW RADIATION DOSE. Bachman, J. A. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1972. 90p. (GNE/PH-72-1). NTIS.

Thesis.

A method was developed to estimate the radiation dose received by an aircrew member in an aircraft in the vicinity of an atmospheric nuclear weapon detonation. The problem is segmented into three parts; determining the radiation field at the aircraft, determining the radiation field within the aircraft, and calculating the radiation dose absorbed by the crew member. The air portion is solved using a computer code with some special treatment of the results, and existing fluence-to-dose conversion factors are used for calculating the crew member dose. The treatment of the aircraft attenuation is developed. The scattered fluence is determined using multigroup diffusion theory. A sample problem is presented using the F-102A interceptor and a hypothetical burst. (auth) (GRA)

7752 (IAEA-R-643-F) EARLY ENZYMIC DIAGNOSIS OF THE RADIATION DISEASE BY FOLLOWING THE CIRCULATORY COERULOPLASMIN LEVEL. Final Report, September 1, 1968–August 31, 1970. Thomas, F. (International Atomic Energy Agency, Vienna (Austria)). 1970. 10p. INIS.

Exposure to radiation is known to alter the serum coeruloplasmin concentration. The feasibility of using the serum coeruloplasmin concentration as a measure of cumulative radiation exposure was studied with the hope of providing a method for monitoring the exposure of workers subjected to chronic low level radiation. The results indicate that a large number of individuals with similar exposure conditions are required to achieve statistically significantly dose estimates. For significant quantitive estimates of doses of 50 Rem above non-irradiated personnel, 174 individuals would be required, and for 100 Rem, 44 individuals would be required. This technique alone therefore does not appear practical for the estimation of cumulative doses from chronic low level radiation exposure. (INIS)

7753 (INIS-mf-289, pp 9-10) DAMAGE TO THE CIRCULATING LYMPHOCYTES OF RADIOTHERAPY PATIENTS: A COMBINED KINETIC AND CYTOGENETIC APPROACH. Rickinson, A.; Chee, C.; Ilbery, P. (Univ. of Sydney). 1972. (CONF-720334-1). INIS.

From fourth human cytogenetics conference; Melbourne, Australia (7 Mar 1972).

Radiation damage sustained by human lymphocytes can be monitored in short-term culture using two independent parameters, (1) changes in the growth kinetics of PHA-stimulated cells, (2) the degree of chromosome damage visualized in metaphase cells. The concerted application of these approaches in attempts to measure the effects of therapeutic irradiation upon the circulating lymphocyte population in man is described. Lymphocyte cultures were set up from radiotherapy patients on a number of occasions spanning their course of treatment. Each time matched cultures were set up under the carefully controlled conditions from normal healthy donors, one such donor being assigned to each particular patient. Radiation damage to the patients' lymphocytes is manifest both during and for some time following the treatment period by a depressed response of the population to mitogenic stimulation and by the appearance of cytogenetic injury in those cells still capable of reaching the first metaphase in culture. It is hoped that this dual approach to the assessment of damage sustained by circulating small lymphocytes may find application in clinical situations where a balance has to be struck between effective radiation dosage to tumor cells and the maintenance of adequate lymphocyte function. (auth)

7754 (ORNL-TM-4017) AN EXAMINATION OF A-BOMB SURVIVORS EXPOSED TO FALLOUT RAIN AND A COMPARISON TO A SIMILAR CONTROL POPULATION. Yamada, H.; Jones, T. D. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 23p. Dep. NTIS.

Since about 1947 it has been thought that A-bomb survivors in Hiroshima and Nagasaki who had experienced the fallout rains and yet displayed no beta-ray burns on the upper convex portions of their anatomies probably did not receive significant levels of exposure from fallout; however, evidence collected by the Atomic Bomb Casualty Commission's survivor observation program tends to indicate the contrary. This paper is an examination of readily available information and represents an attempt to establish conclusions that would either promote or discourage more detailed analyses of the effects of radiation fallout on an otherwise lightly exposed population. (auth)

7755 NEW VALUES FOR EPIDERMAL THICKNESS AND THEIR IMPORTANCE. Whitton, J. T. (Central Electricity Generating Board, Berkeley, Eng.). Health Phys.; 24: No. 1, 1-8(Jan 1973).

The thickness of the epidermis on 214 skin samples from 188 volunteers has been measured by a new technique which involves a weight determination. The results do not depend on the natural elasticity of the skin and therefore differ significantly from those of earlier conventional methods of measurement where no correction is made for shrinkage. It has been shown that epidermal thickness is not dependent on age (between 15 and 89 yr) or sex but varies significantly with body site. For radiological protection purposes it is appropriate to replace the value of 7mg/cm^2, currently used for minimal epidermal thickness on all body sites, by a value of 4mg/cm^2 for average epidermal thickness. Where it is justifiable to distinguish between body sites three different regions could be considered having average epidermal thicknesses of 4, 8 and 40mg/cm^2. Design parameters are suggested for personal dosimeters appropriate for use on each of these three areas. (auth)

7756 RADIOGRAPHY OF POTENTIALLY PREGNANT FEMALES. Ardran, G. M.; Kemp, F. H. (Radcliffe Infirmary, Oxford). Brit. Med. J.; 4: No. 5837, 422-3(18 Nov 1972).

The Code of Practice for the Protection of Persons against Ionizing Radiations arising from Medical and Dental Use (London, H.M.S.O.), is discussed in relation to the radiography of potentially pregnant women. It is claimed that an average diagnostic exposure might double the natural incidence of leukemia. Methods of tackling the problem are discussed in relation to hospital radiological services and appointment procedures etc, but it is pointed out that the code indicates that it is the responsibility of the referring doctor to deal with this aspect. (UK)

7757 CURIES AND MILLIREMS. Mechali, D. (CEN, Fontenay-aux-Roses, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 94, 14-16(Mar 1972). (In French).

The ways in which the release of radioactive substances into the environment can lead to irradiation of the population are discussed. The manner in which this irradiation can be evaluated is given together with some examples relevant to existing installations. The different ways in which the population can be contaminated depend upon the nature of the substance released, the way in which it is released, and the characteristics of the environment. Release in the atmosphere, water courses, lakes, the sea, and estuaries is considered. (France)

7758 CHANGES OF LYMPHOCYTES IN THE PERIPHERAL BLOOD IN RADIATION THERAPY. Kozinets, G. I.; Bogoyavlenskaya, M. P.; Al'perovich, V. V.; Bykova, I. A.; Orlov, G. P. (Central Inst. of Hematology and Blood Transfusion, Moscow). Med. Radiol.; 17: No. 11, 11-16(Nov 1972). (In Russian).

The functional properties of lymphocytes were investigated in 16 patients with mammary gland cancer or that of genitalia immediately prior to treatment and at remote periods (10 to 18 years) after radiation therapy. It was found that in addition to a decreased number of lymphocytes following radiotherapy, their immunological functional properties were also changed. This was manifested by disorders in the blast transformation process and a decrease in the uptake of ^{3}H-thymidine-label by cultured cells and in cultures with phytohemagglutinin. (TSI)

7759 EXPOSURE OF PATIENTS DURING X RAY DIAGNOSIS. Koga, S. (Nagoya Univ., Japan); Yamamoto, C.; Tamiya, T. Rinsho Hoshasen; 17: No. 2, 122-9(Feb 1972). (In Japanese).

Though x-ray diagnosis plays an important role in modern medicine, exposure has a linear relation with radiological hazard in view of safety. Points to be considered concerning radiation dose to patients, judging from the seriousness of its radiological hazard, are gonad dose and marrow dose, but skin dose is a most fundamental point as skin is the first part of the body to obtain x-ray application. First step to adjust the dose may

be to investigate the actual state of the dose. Determination of the skin dose with thermal fluorescent dosimeters proved that digestive tract contrast, blood path catheter inspection, and myelography might require a dose above 10 R for one-time diagnosis, while cystopyelography, oviduct contrast, blood path contrast, and laminography as well as pelvis, backbone, and head, required above 1 R dose. Highly sensitive record system should be chosen for reduction of the dose. The gonad dose is important in connection with genetically significant dose, while the marrow dose might be related to leukemia significant dose. Both of them are reported according to the Report of United Nations Scientific Committee. (Japan)

7760 CHANGES IN CERTAIN PERIPHERAL BLOOD INDUCED FOLLOWING A WHOLE-BODY IRRADIATION OF MAN. Brilliant, M. D.; Vorob'ev, A. I. Probl. Gematol. Pereliv. Krovi; 17: No. 1, 27-31(Jan 1972). (In Russian).

Changes in the leukocyte and thrombocyte levels in man were investigated following a radiation dose of from 50 to 200 rads. The extent of leucopenia and thrombocytopenia increased with increased radiation dosage. The time required for maximum lowering of the count of leucocytes and thrombocytes at each radiation dose had a constant quantity and a consistent change of leukocyte and thrombocyte levels with radiation dose was noted. A drop in the leucocyte level occurred in the course of 8 to 11 days; then the level began to rise for about three weeks. At a dose of 200 rads agranulocytes were observed. With regard to thrombocytes, at a dose of 150 rads, thrombocytopenia was initiated at the end of 3 weeks following irradiation, and for 200 rads, at the end of 2 weeks. (tr-auth) (INIS)

7761 RADIOBIOLOGICAL ASPECTS OF FAST NEUTRON THERAPY. Field, S. B. (Hammersmith Hospital, London). Proc. Roy. Soc. Med.; 65: No. 10, 835-9(Oct 1972).

The effectiveness of fast neutrons for radiotherapy is discussed. Three major differences between neutrons and x rays are pointed out. They are: the RBE for neutrons is greater than that for x rays; the RBE for neutrons increases as the dose decreases; and the oxygen enhancement ratio for neutrons is less than that for x rays. The results of tumor therapy experiments in animals suggest that some tumors might always be more effectively treated with neutrons, while some are treated equally as effectively with x- or γ rays provided sufficient information is known about these tumors to select the optimum fractionation scheme with x- or γ rays. (E.R.B.)

7762 COMMENT ON THE RAP, A PROPOSED UNIT FOR DIAGNOSTIC X-RAY PROTECTION. Burlin, T. E.; Wheatley, B. M. (Polytechnic, London). Health Phys.; 24: No. 1, 113 (Jan 1973).

It is pointed out that the proposed quantity roentgen–area–product (rap) is not related to Mean Energy Imparted nor any quantity currently used in radiological protection. Thus, although the meters mentioned by Cameron (Health Phys.; 21: 879(1971)) are useful due to the desirability of limiting field size and exposure in routine monitoring in diagnostic radiology, since their readings are not related to any quantity recognized as a useful basis for radiological protection it would be misleading to use their results quantitatively. (UK)

7763 DANGER: RADIOACTIVITY. EFFECT OF IONIZING RADIATION ON MAN. FIRST-AID MEASURES WHEN INCIDENTS WITH RADIOACTIVE SUBSTANCES OCCUR. Betz, B.; Niklas, K. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). Brandschutz; 26: No. 3, 62-5(1972). (In German).

A brief description is given of terms and definitions used in radiation biology (e.g., QF, DE, D, RBE, external and internal irradiation) and of each radiation injury, e.g., acute radiation syndrome, late radiation effects. First aid measures at radiation incidents by auxiliary personnel such as the fire department are described. (GF)

7764 EXPOSURE OF RADIOLOGISTS TO X-RAYS DURING CHEST AND ABDOMINAL FLUOROSCOPIES. Jankowski, J. (Inst. of Occupational Medicine, Lodz, Poland). Phys. Med. Biol.; 17: No. 6, 814-22(Nov 1972).

In a search for a relationship between the exposure recorded by a film badge at a single point of the body and the mean whole-body exposure to x rays, measurements were made on radiologists at various parts of the body. The ionization chambers used were fixed to eleven points on the radiologist's body surface during fluoroscopy, and a series of between 10 and 30 chest examinations and 3 to 8 abdominal examinations were carried out. In all, 106 measurements were made on 38 radiologists who had examined a total of 1112 patients. The x-ray emission time per patient, x-ray tube voltage (65 to 75 kV), tube current, and other relevant parameters were recorded. The results have shown that the mean whole-body surface-weighted exposure amounted to 2.33 μR min^{-1} mA^{-1} and the distribution of individual measurements was found to fit a log-normal pattern. It was found that the site at which the film badge has been commonly worn so far (the upper part of the chest) does not yield the exposure values closest to the mean whole-body values, and should be changed to the height of the last right rib in front of the chest. (auth)

7765 RADIOSENSITISATION. Adams, G. E. (Mount Vernon Hospital, Northwood, Eng.). Lancet; 2: No. 7783, 921 (28 Oct 1972).

Brief critical comments are made on a previous editorial (Lancet, p.638, (Sept. 23, 1972)). It is suggested that the theory behind the use of electron-affinic sensitizers is that they are much less rapidly metabolized than is O_2 itself and therefore can diffuse into hypoxic areas even if they have diffusion rates that are lower than that of O_2. It is pointed out that in vivo evidence is not available, but that the model in vitro spheroid system points to this. It is also pointed out that there is as yet little information of the toxicity to man of electron–affinic sensitizers, with the possible exception of Synkavit. The drug N.D.P.P. is mentioned as having a high degree of tolerance in mice and the nitrofurans are given as an example of fairly non-toxic drugs. (auth)

Vertebrates

Refer also to abstracts 7727 and 7730.

7766 (AD–743063) CANINE CARDIOVASCULAR HOMEOSTASIS IN THE GASTROINTESTINAL RADIATION SYNDROME. Kabal, J.; Baum, S. J.; Parkhurst, L. J. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Mar 1972. 28p. (AFFRI-SR-72-4). NTIS.

Beagles were subjected to 1500 rads of whole-body pulsed gamma-neutron radiation. Forty-eight and seventy-two hours later the animals were anesthetized and the major cardiovascular parameters were obtained. Thereafter, the hemodynamic regulation was studied after intravenous administration of 5.0 μg/kg epinephrine. It was observed that at 48 hrs postirradiation, the major cardiovascular parameters were unchanged. After 72 hrs, with the exception of the mean blood pressure, significant hemodynamic deterioration developed. The average stroke volume and stroke work decreased 50% as compared with the control nonirradiated average values. The median total peripheral resistance, meanwhile, increased in the same magnitude. The blood pressure response after epinephrine was prolonged and significantly higher at 1 min postinjection in the 48-hr group. The vagal reflex bradycardia became less expressed. After 72 hrs postirradiation, the epinephrine-induced cardiovascular regulation was further deteriorated. The epinephrine effect demonstrated that in the gastrointestinal radiation syndrome prior to the cardiovascular collapse, a latent imbalance of alpha and beta adrenergic activity is already present. The data indicate further that the cardiovascular deterioration is peripheral rather than myocardial in origin. This study supports the concept that functional vascular alterations underlie the development of the so-called gastrointestinal radiation syndrome. (auth) (GRA)

7767 URINARY CATECHOLAMINES IN RATS IRRADIATED WITH A WHOLE BODY LETHAL DOSE. Cession-Fossion, A.; Lemaire, M. (Univ., Liege). Compt. Rend. Soc. Biol.; 165: No. 12, 2448-51(1971). (In French).

A lethal whole-body radiation dose of 200 R increased the noradrenaline and the adrenaline contents of the urine of rats; the quantities of adrenaline increased after the second day and those of noradrenaline increased after the third day, but in smaller proportions. (France)

7768 DEVELOPMENTAL DISTURBANCES OF THE BRAIN. OBSERVATIONS FROM THE VIEW POINT OF COMPARATIVE DEVELOPMENTAL PATHOLOGY. Murakami, U. (Aichi Prefectural Colony, Kasugai, Japan). Shinkei Kenkyu No Shimpo; 16: No. 3, 406-14(Jun 1972). (In Japanese).

A review is made of the literature on the causes and morphogenesis of major cerebral malformations, with special emphasis on the pathological effect of prenatal x-radiation exposure on the developing brain of animals. Abnormalities produced in the course of closing of the neural tube include exencephalia, spina bifida aperta and latent spina bifida, and the developmental disturbances of the cerebellum such as Arnold–Chiari syndromes. Those that are produced after closing of the neural tube consist of holoprosencephaly, hydrocephalus, and microcephalus. X radiation of 200 R given to mice of nine-days pregnancy and also to rats of ten-days pregnancy both produced hydrocephalus associated with various pathological effects. Microcephalus (or vaulted cranium) was developed in mice of eleven-days pregnancy that received

200 R x ray irradiation. Observation was made on the postnatal development of the brain of mice receiving 200 R x rays on the thirteenth and seventeenth day of pregnancy. Advanced hydromicrocephalus was produced in those irradiated on the thirteenth-day of pregnancy associated with a decrease in cortical cells and a disturbance in morphological structure. Similar disorders were observed in those irradiated on the fifteenth-day of pregnancy, however, cells that had completed vagrant by the time of irradiation were relatively well preserved. In contrast, disturbances were relatively minor in those treated on the seventeenth-day of pregnancy although the developmental disturbance of individual cell was more serious compared with the former group. X irradiation of animals also produced differentiation disorders of the cerebellum that are characteristic of Minamata disease. (Japan)

7769 EFFECTS OF SULFUR CONTAINING RADIOPROTECTIVE SUBSTANCES ON THE METABOLISM OF ANIMALS. Duyckaerts, C. Liege; Liege Univ. (1972). 137p. (In French). Thesis.

The influence of cystamine, cysteamine, and cysteine on oxidation-reduction potentials was studied. Oxidation-reduction potentials were determined in lactate, pyruvate, 3-hydroxybutyrate, and acetoacetate of blood. The administration of cystamine brought about in rat blood a rise in the ratios of lactate/pyruvate and of 3-hydroxybutyrate/acetoacetate. Cysteamine and cysteine did not affect oxidation-reduction in the tissues. In mice, after injection of cystamine, a smaller decrease of the oxidation-reduction potential was observed; cysteamine did not reduce the potential. In the rat, cystamine and cysteamine induced a hyperglycemia; a hyperlactacidemia was observed after injection of cystamine and this suggested a stimulation of muscular glycogenolysis. Stimulation of hepatic glycogenolysis by cystamine is manifested by a depletion of glycogen reserves and an accumulation of hexose-monophosphates and glucose. Several experiments suggest a stimulation of glucose formation from lactate formed in the extra-hepatic tissues. Radiation experiments were undertaken in order to see if the reactions caused by cystamine contributed to the radioprotection which could be due to reduced concentration of oxygen or to its metabolic consequences. (H.L.W.)

7770 GLYCOGEN ACCUMULATIONS AND ^{3}H GLUCOSE UTILISATION FOLLOWING X IRRADIATION, HYPERBARIC OXYGENATION, AND ADMINISTRATION OF VASODILATOR DRUGS. Lierse, W. (Univ., Hamburg). Eur. Neurol.; 6: 88-91(1971).

The accumulation of glycogen and the uptake of tritium-labeled glucose in the brain and retina of guinea pigs and the retina of rats were determined following hyperbaric oxygenation (3 atm), administration of vasodilator drugs (Roniko), or x irradiation (500, 1000, 3000 R). Hyperbaric oxygenation and x irradiation generally led to increases in glycogen accumulation while administration of Ronikol decreased accumulations. The uptake of tritium-labeled glucose was reduced by hyperbaric oxygenation and x irradiation. These results and the mechanisms underlying them are discussed. (E.R.B.)

7771 PROCESS OF SELECTION IN LETHALLY IRRADIATED MICE TREATED WITH MIXED BONE MARROW OF ALLOGENOUS AND XENOGENOUS DONORS. Kondic-Mitin, N. Zagreb; Univ. of Zagreb (1970). (In Serbo-Croatian). Thesis.

Those processes that take place after the transplantation of mixed bone marrow from several donors into lethally irradiated recipients were investigated. The following problems were elaborated: the possibility of following of the process of selection of the optimal donor from the parts of the recipient animal by the analysis of marker-chromosomes; whether the selection is a regular process; the influence of the recipient on the final result of the process of selection; and the survival of transplanted skin in radiation chimerae. In that way it was possible to determine the immunological condition of animals during the process of selection and then the intensity of secondary diseases and the frequency of mortality in lethally irradiated mice after transplantation of mixed bone marrow. As recipient animals, adult hybrid mice were used $(C57BL \times CBA-T6T6)F_1$ and $(A \times CBA-T6T6)F_1$. The donors of bone marrow were their parental stocks (C57BL respectively A/H, CBA/H-T6T6) and white rats of the stock Lewis. As recipients and donors were used male white mice 4 to 6 months old and as donors male white rats 2 to 3 months old. The radiation dose for white mice was 800 or 950 R. The experimental animals were placed at a distance of 49 cm from the source of radiation delivered at 92 R per min. Further conditions of radiation were 220 kV and 15 mA. The following results were obtained on the basis of analysis of chimerae of hybrid mice F_1 irradiated with 800 or 950 R and immunized with the mixed bone marrow of several genetically different donors: After administration of a large amount of mixed bone marrow to irradiated recipients, the process of selection occurs; during the process of selection in lymphatic organs of recipients, there are cells of all donors. The percentage of donor's cells in each animal and in each lymphatic organ of the same animal is different; in all combinations of investigated stocks, the time of process of selection is less than 14 days; before the end of process of selection in irradiated recipients there remains nearly only the cells of one donor. On the basis of results of survival of hybrids immunized with mixed bone marrow or with bone marrow of single donor the following conclusions can be drawn: The time coincidence between the process of selection and the appearance of secondary diseases does not exist; in the case of close affinity of several donors in relationships to the recipient, the cells of the most favorable donor do not remain necessary. (Bull. Sci., Sect. A, Sci. Nat. Tech. and Med.)

7772 EFFECTS OF LOW DOSE OF RADIATION ON THE LIVING BODY. Takebe, Hiraku (Osaka Univ.). Kagaku (Tokyo); 42: No. 2, 79-85(Feb 1972). (In Japanese).

A review is presented of the effects of low dose irradiation. Topics discussed are: the concept of permissible dose; effects of 5 to 25 R doses on mutation induction in Drosophila and other studies on hereditary effects; experiments on silkworms and mice to determine relationships between dose rates and mutation; delayed effects of radiation on atomic bomb survivors in Hiroshima and Nagasaki; mechanisms for repair of radiation damage in relation to genetics; and application of the target theory in studies on hereditary effects of environmental pollutants. (H.L.W.)

7773 γ-IRRADIATION OF PHOTORECEPTOR CELLS IN VIVO: DNA REPAIR AND RETINAL FUNCTION. Wheeler, K. T.; Paulter, E. L.; Lett, J. T. (Colorado State Univ., Fort Collins). Exp. Cell Res.; 74: No. 1, 281-4(Sep 1972).

A review is presented of studies on the strand-break rejoining mechanisms operating on damaged DNA in irradiated photoreceptor cells. Following gamma ray doses below the critical range retinal photoreceptor cells of the rabbit are able in vivo to rejoin strand breaks within the DNA structural subunits and restore the links between them. The electroretinogram is not reduced by a dose of 900 R; in fact, a small enhancement is observed during the early recovery period. Although preliminary data imply that loss in retinal function is coupled with efficacy of DNA repair in photoreceptor cells, a definite relationship cannot be postulated. (H.L.W.)

7774 CELL MOVEMENT IN IRRADIATED INTESTINAL EPITHELIUM. Matsuzawa, D.; Tsubouchi, S. (Aichi Cancer Center, Nagoya, Japan). Nippon Ishikai Zasshi; 67: No. 2, 106-13(Jan 1972). (In Japanese).

A series of studies was made to clarify the difference or similarity in movement of normal cells or cells after irradiation in intestinal epithelium of normal animals and germ-free animals and elucidating the effect of intestinal flora on living bodies. In the study of radioresistance of germ-free animals based on the death caused by intestinal damage following irradiation, the period taken for a Swiss strain germ-free mouse to die after receiving irradiation (incubation period of the death caused by intestinal damage due to irradiation) was 7.2 days and it was about two times that of the normal mouse, 3.5 days. The half-lethal dose (LD 50) within ten days was 1300 rad in the normal mouse and 2100 rad in the germ-free mouse, which indicates that the latter had more resistance than the former. With respect to the mechanism of radioresistance based on two parameters, that is, prolongation of survival time and increase of LD 50, a description was given of cell migration in intestinal epithelium under normal and severely damaged conditions following radiation namely, epithelial cell growth in intestine observed by autoradiography with ^{3}H-thymidine, especially variation of cell nuclear cycle. About proliferation and differentiation of epithelial cells of intestine at convalescence stage, description was made as to the reduction of ^{3}H-thymidine incorporated into regenerative epithelial cells after irradiation, that is, the mechanism of disappearance regarded as the local control mechanism. Mono-contamination of germ-free mice was made by using Escherichia coli, Streptococcus fecalis, Alkylgenus fecalis, Clostridium dificile, or Pseudomonas arugenosa out of the intestinal flora of normal mice. After one month of disappearance of acute inflammation, 850 R of whole-body irradiation was made and survival time of mice was examined. The results showed the fact that some kinds of intestinal flora have an intensification or defensive effect against radiation. (Japan)

7775 HYPERTENSIONAL ACTIVITY OF BRADYKININ AND HISTAMINE ON HEALTHY RATS. Gaponyuk, P. Ya.; Kalinkina, T. N. (Inst. of Medical Radiology, Obninsk, USSR). Stud. Biophys.; 30: No. 3, 197-202(1972). (In Russian).

Bradykinin (2 γ/100 g) and histamine (6 γ/100 g) injected into the jugular vein of healthy rats anaesthetized with Nembutal de-

crease blood pressure to 48% and 29%, respectively. In all cases, the blood pressure returns to its original levels by 5 min after injection. Bradykinin and histamine injected i.v. into rats 3 to 4 days after irradiation (whole-body irradiation of the animals was carried out with ^{60}Co γ rays, 800 R, 41 R/sec.) led to a diphasic change of blood pressure: the decrease of blood pressure within the first 5 to 10 sec and a following increase of blood pressure. Injection of bradykinin leads to maximal hypertension (to 44% exceeding the original level). In all cases, the blood pressure returns to its original levels by 5 min after injection. (auth)

7776 INVESTIGATION OF FREE-RADICAL PROCESSES IN CELLULAR ORGANELLAE OF THE LIVER BY THE METHOD OF GRAFT COPOLYMERIZATION. Arkhipov, A. S.; Burlakova, E. V.; Kozlov, Yu. P. (Moscow State Univ.). pp 3-11 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

A study was made of the postradiation free-radical processes in cellular fractions of the liver of white male rats exposed to 200, 650, and 1500 R doses of total gamma irradiation. A method of AA C-14 graft copolymerization developed by Kozlov and Tarusov (1966) is used in detecting free radicals in the samples. The various fundamental changes observed in the free radical processes in the liver organellae of irradiated rats are discussed. (IAA)

7777 ULTRAWEAK LUMINESCENCE OF THE CELLULAR ORGANELLAE OF IRRADIATED ANIMALS. Danilov, V. S.; Kozlov, Yu. P. (Moscow State Univ.). pp 21-9 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

Investigation of the kinetics of radiation damage and spectral properties of the cellular organellae of the liver of white male rats exposed to 200, 600, and 1500 R doses of gamma radiation was conducted. The time variable changes in the intensity of the luminescence of irradiated cell suspensions are discussed, noting that the damaging effects of stronger radiation doses are more severe. (IAA)

7778 USE OF BIOLOGICAL OBJECTS AND OF A RADIOMIMETIC MODEL IN STUDYING THE PROPERTIES AND THE PROTECTIVE ACTION OF RADIOPROPHYLACTIC MATERIALS. Kudryashov, Yu. B. (Moscow State Univ.). pp 60-98 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

Tentative evaluation of the radioprotective action of a large group of aminoalkylthiols, aminoalkyl disulfides, aminoalkyl isothiurons, aminoalkyl thiosulfuric acids, thiazolidine, and inhibitors of free radical reactions in mouse tissues, erythrocytes, and yeast cells was made. The objects were exposed to various x ray doses or to the action of various radiomimetic agents, such as oxidized oleic acid that simulates most completely the action of lipid radiotoxins. It is expected that a radiomimetic model using yeast cells will contribute to further studies of the effectiveness of new radioprotective agents. (IAA)

7779 MEDIATING ACTION OF RADIOPROTECTORS UNDER CONDITIONS ENCOUNTERED IN LIVING SYSTEMS. Sumarukov, G. V. (Moscow State Univ.). pp 115-23 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

A review is presented of Soviet and foreign studies concerning the mechanism of the radioprotective action of various chemical agents on the organism. Experiments of Kudriashev et al. (1966) on mice with cystamine, cysteamine, and aminoethyl are considered. Equal decreases in the redox potential were observed, suggesting only a mediating action of these radioprotective agents. (IAA)

7780 PROTECTION OF MAMMALS FROM IONIZING RADIATION WITH THE AID OF DITHIOLS. Tarasenko, A. G.; Fedoseev, V. M. (Moscow State Univ.). pp 124-40 of Fizikokhimiya Luchevogo Porazheniya. /Kozlov, Yu. P. (ed.). Moscow; Izdatel'stvo Moskovskogo Universiteta (1969). (In Russian).

An evaluation is made of the protective effect of a large group of dithiols against ionizing radiation in mammals in the light of published Soviet and foreign studies. Experiments with 2,3-dimercaptopropylamine and its derivatives on white mice are described in detail. Theories concerning the mechanism of their radioprotective action are discussed. Contrary to an existing view, it is believed that the oxygen pressure drop produced by these compounds in tissues is not immediately involved in the mechanism of protective action but only accompanies it and may prolong the protective effect. (IAA)

7781 EFFECT OF DOSE-RATE (γ-RADIATION) ON THE MITOTICALLY-ACTIVE AND DIFFERENTIATING GERM CELL OF THE PRENATAL MALE RAT. Erickson, B. H.; Martin, P. G. (UT-AEC Agricultural Research Lab., Oak Ridge, TN). Int. J. Radiat. Biol.; 22: No. 6, 517-24(Dec 1972).

Rat fetuses, aged 15, 17, or 19 days of gestation, were subjected to 95 rads of ^{60}Co γ radiation administered at rates of 0.95, 9.5, or 45 rads/min and examined 6, 28, and 49 days after birth. Dose-rate effects were assayed at day 6 by enumerating germ cells in 150 cross sections of seminiferous tubules and measuring testicular weights. At days 28 and 49, dose-rate effects were determined by means of testicular weights and counts of fertile and sterile tubular cross sections. Germ-cell survival was inversely related to age at irradiation. Dose-rate effects were pronounced ($P < 0.05$) in testes irradiated at day 15 (germ cells mitotically active), equivocal at day 17 (germ cells mitotically active and differentiating), and absent at day 19 (germ cells differentiating only). Both testicular weights and tubular counts measured at day 28 were apparently directly related to the germ-cell counts. The mitotically-active gonocyte was comparatively refractory to the necrotizing effects of ionizing radiation, and the degree of refractoriness was materially influenced by dose-rate. Conversely, the gonocyte undergoing differentiation was highly susceptible to the cell-killing effects of irradiation and the degree of susceptibility was little influenced by the dose-rate. (auth)

Invertebrates

7782 EFFECT OF RADIATION-INDUCED MUTATIONS ON THE FITNESS OF DROSOPHILA POPULATIONS. Blaylock, B. G.; Shugart, H. H. Jr. (Oak Ridge National Lab., TN). Genetics; 72: No. 3, 469-74(Nov 1972).

The change in frequencies of Drosophila melanogaster and D. simulans in competition experiments was used to measure the effect of γ radiation on the fitness of a population. A dose of 250 or 500 rads given to the males of highly inbred lines of D. simulans at the beginning of competition and every three weeks thereafter increased the relative frequency of the irradiated population. If the dose was increased to 1000 rads, the deleterious effects of radiation became too great a burden on the population, and the frequency of the irradiated population decreased. From these results it was concluded that below certain doses the introduction of radiation-induced mutations into a highly homozygous population would increase the fitness of the population. (auth)

7783 MODIFICATIONS PRODUCED BY GAMMA RADIATION IN THE OVIPOSITION OF WORKER AND FEMALE ANTS (DOLICHODERUS QUADRIPUNCTATUS). Torossian, C.; Causse, R. (Univ., Toulouse). Ann. Zool.-Ecol. Anim.; 3: No. 4, 427-41 (1971). (In French).

Dolichoderus quadripunctatus (worker) ants were exposed to different doses of γ radiation. Losses in fertility and an eventual sterility were observed. The females of the same species are very resistant to γ radiation. Their mortality rate for mean doses of between 5000 and 50000 rads is very small. Their lifetimes are however diminished (particularly for doses exceeding 50000 rads). The resistance threshold is between 50000 and 75000 rads. The fertility of the females is reduced to a residual level, all the eggs laid being abortive. A further series of experiments was performed to disturb the equilibrium between the females and the workers. In this series of experiments, only the queen was irradiated and it was observed that the workers began laying eggs even when the queen was still laying. Irradiation of the workers with small doses of radiation made them sterile. However, the introduction of young larvae led to the production of workers, females, and even some winged females. (France)

7784 EXPERIMENTAL DEMONSTRATION OF HOLOKINETIC CHROMOSOMES, AND OF DIFFERENTIAL RADIOSENSITIVITY DURING OOGENESIS, IN THE GRASS MITE, SITEROPTES GRAMINUM (REUTER). Cooper, R. S. (Univ. of California, Riverside). J. Exp. Zool.; 182: No. 1, 69-94(Oct 1972).

Early cleavage stages, mature eggs and developing oocytes of the grass mite Siteroptes graminum (Reuter), formerly Pediculopsis graminum (Reuter), (2n = 6; males haploid), were irradiated to: test the hypothesis that the chromosomes are not monokinetic, determine whether the chromosomes respond differently to irradiation during oogenesis and cleavage, and find out whether a special region on the chromosome is required for elaboration of its chromosomoid (Feulgen-negative body otherwise resembling the chromosome) which is left on the equator during both the meiotic and early cleavage mitoses. Fixation occurred 1–27 hours after irradiation. Chromosomal complements of more than 160 embryos (egg through 128 cell), and a few meiotic figures, were analyzed. Clusters of cells with decipherable chromosomal complements of 8–16 elements occurred frequently, and in especially favorable embryos karyotypes of all or nearly all the blastomeres could be analyzed. Many chromosomal fragments passed through at least three to five cleavage divisions in normal or nearly normal

manner. Fragments which had come through one or both meiotic divisions behaved in blastomeres in a manner similar to those induced in cleavage stages. The chromosomes, therefore, are holo- or polykinetic in the classical sense. The tiniest fragments and very large translocations, however, tended to missegregate or to be eliminated. Some fragments were observed en route to or at the poles in both meiotic divisions. However, aberrancies in chromosomal behavior were more frequent during the maturation divisions, especially anaphase and telophase I, than during cleavage mitoses. Differential radiosensitivity was detected during the course of oogenesis, and between oogenesis and cleavage stages, the first known case in the class Arachnida. As earlier stages were irradiated, there was a trend in blastomeres toward fewer fragments, and far more normal and nearly normal karyotypes. Irradiation of cleavage stages yielded most fragments. Probable causes of this differential radiosensitivity are discussed. In the few cases with well-preserved, discrete chromosomoids the relative size of the chromosomoid and its associated chromosomal elements (including very small fragments) were correlated, and in several cases more than the diploid number of each was present. This suggests, but does not prove, that any part of the chromosome can elaborate chromosomoidal material. Possible causes, other than restriction of the kinetochore, for aberrancies in chromosomal behavior during both somatic and meiotic mitoses are discussed. The more recent literature on holokinetic chromosomes is analyzed, and new speculations about differences between mono- and holokinetic chromosomes are made. Factors of importance in design of experiments to determine the location of kinetochores are discussed. (auth)

Radionuclide Effects (Internal Source)

Refer also to abstracts 7486 and 7580.

Man

Refer also to abstracts 7364, 7498, 7557, and 7575.

7785 THEORETICAL RADIATION DOSE TO THE HUMAN SYSTEM FROM ASSIMILATED TRITIUM. Croach, J. M. (E. I. Du Pont de Nemours and Co., Wilmington, DE). Health Phys.; 24: No. 1, 17-22(Jan 1973).

A theoretical model for tritium behavior in man shows that, for tritium uptake, the radiation energy deposition per unit weight of body hydrogen is essentially invariant for all components of the human system. The model is based on the assumption that tritium enters the body in a manner typical of hydrogen. If assimilated tritium behaves the same as ordinary hydrogen, the amount of tritium passing through any body subsystem varies directly with the hydrogen turnover rate, while the residence time varies inversely with turnover rate. The specific energy deposition in any subsystem is, therefore, the same as that in any other subsystem for tritium assimilated in a manner typical of hydrogen. Pathway effects associated with preferential entry of tritium in atypical hydrogen streams can be significant. An extension of the base model also illustrates that assimilated tritium that becomes permanently bound will not contribute significantly to the total dose. The analysis of a previously reported experiment is shown to conform with the predictions of the theoretical model. (auth)

7786 LONG-TERM EXPOSURE OF SEVERAL PERSONS TO MISLAID Ra APPLICATORS IN A MEDICAL ESTABLISHMENT. Klener, V. (Inst. of Hygiene and Epidemiology, Prague); Tuscany, R.; Kudrna, J. Prac. Lek.; 23: No. 7, 237-40(Sep 1971). (In Czech).

An analysis is presented of uncontrolled exposure of four female workers at a medical establishment where approximately 30 years ago, probably in adaptions, 7 application needles containing a total of approximately 15 mg ^{226}Ra had been built into the floor. Because the work schedule in recent years was known, the measured dose rates made it possible to estimate the yearly exposure to be 1.5 to 12 R. No clinical or hematologic deviations were ascertained in the exposed women. One year after the end of the exposure, a repeated incidence of cells with so-called unstable aberrations was disclosed by karyologic examination of the peripheral lymphocytes. According to present knowledge this cannot be considered a manifestation or a prodrome of illness. (NSA of Czech.)

7787 RADIOACTIVITY OF SOME HUNGARIAN SPRING-WATERS AND THE DOSE ORIGINATING FROM THEIR CONSUMPTION. Kurczne, Csiky I.; Gaalne, Dippold, A.; Polgar, E.; Toperczer, J. (Orszagos Kozegeszsegugyi Intezet, Budapest). Izotoptechnika; 15: No. 6, 354-7(Jun 1972). (In Hungarian).

A drinking cure with the radioactive spring water of the Juventus spring, Budapest, does not involve any body burden to the patient. (auth)

7788 CALCULATION AND MEASUREMENT OF THE ORGAN DOSES DUE TO INTERNAL γ-EMITTERS. Feher, I.; Koblinger, L.; Szabo, Peter P. (MTA Kozponti Fizikai Kutato Intezete, Budapest). Izotoptechnika; 15: No. 6, 289-93 (Jun 1972). (In Hungarian).

Monte-Carlo calculation and measurement of dose absorbed in the lungs of a human (BOMAB) phantom by means of LiF powder suspended in organic carrier from ^{60}Co and ^{131}I sources placed in the thyroid and testis are given. (auth)

7789 BIOLOGICAL EFFECT OF MEDICALLY APPLIED RADIONUCLIDE ^{131}I ON THE RADIORESISTANCE OF RED BLOOD CELLS. Geszti, O. (A Magyar Nephadsereg Egeszsegugyi Szolgalata, Budapest).; Predmerszky, T.; Karika, Zs.; Lovanyi, I. Izotoptechnika; 15: No. 6, 315-18(Jun 1972). (In Hungarian).

Four days after the application of ^{131}I, an increase in membrane permeability and a decrease in resistance to low dose in vitro x-ray irradiation was observed in erythrocytes. (auth)

Animals

7790 SPERMATOGENESIS IN DERMACENTOR VARIABILIS (SAY) IN RELATION TO DURATION OF ATTACHMENT AND THE PRESENCE OF CHROMOSOMAL ABERRATIONS IN STOCKS INJECTED WITH RADIOACTIVE GLUCOSE (ACARINA: IXODIDAE). Homsher, P. J.; Sonenshine, D. E. (Old Dominion Univ., Norfolk, VA). Contract AT(40-1)-3514. J. Med. Entomol.; 9: No. 2, 171-7(28 Apr 1972).

Spermatogenesis in relation to the duration of attachment and radioactivity resulting from injection of ^{14}C-glucose into females of the American dog tick, Dermacentor variabilis (Say) was studied. The interval between the time of tick attachment and the earliest observation of mitosis and each stage of meiosis was noted, but these times are regarded as approximations. Mitotic divisions in spermatogonial cells were first detected after 24 to 29 hr of attachment; meiotic divisions after as few as 63 hr to at least as long as 149 hr. First appearance of the individual meiotic stages was sequential for the conditions under which our study was done. The number of chromosomes (2n = 21 in males) and details of their morphology in this study agree with those of previous workers. Crossing over in D. variabilis males is indicated from the observed meiotic configurations of the chromosomes. Stocks injected with radioglucose exhibited abnormal reductions in testis size and chromosome breakage in some spermatocytes. (auth)

Microorganisms

7791 VARIATIONS, AS A FUNCTION OF EXPERIMENTAL CONDITIONS, OF THE EFFECTIVENESS OF DISINTEGRATIONS OF ^{32}P INCORPORATED IN E. COLI. Apelgot, Sonia (Inst. of Radium, Paris). Int. J. Radiat. Biol.; 22: No. 6, 557-77(Dec 1972). (In French).

The experiments described show that for the bacteria of the strain used (Escherichia coli) the α value (probability of inactivation by each transmutation of ^{32}P incorporated) depended on the specific activity used. At each of the temperatures studied (0 and −196°C), there were two α values. The higher one, α_S, characterized specific activities lower than 8 or 15 Ci/g P, according to the temperature of experiment, and the lower one, α_r, characterized the higher specific activities. The addition of D-L-pantoyl-lactone to the growth medium enabled it to be shown that this result is not linked with the formation of snakes, which appear when bacteria are grown in the presence of a high ^{32}P specific activity. The addition of caffeine in the post-treatment medium, when bacteria are counted, indicated the action of this compound. These results prove that bacteria are able to repair some of the damage caused by transmutation of the ^{32}P atoms incorporated. (auth)

Nuclide Kinetics and Toxicology

Refer also to abstracts 7559 and 7560.

Man

Refer also to abstracts 7785 and 7949.

7792 (CEA-N-1568) ^{90}Sr LEVELS IN HUMAN BONES COLLECTED IN 1971. Jeanmaire, L.; Patti, F.; Gros, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France).

Centre d'Etudes Nucleaires). Nov 1972. 30p. (In French). Dep. NTIS (U. S. Sales Only).

The levels of ^{90}Sr and certain other stable strontium isotopes in human bones collected mainly in the Paris area during 1971 are presented. The results are presented in tabular form according to the different age classes. It is concluded that the main tendency is toward a stabilization in the level of activity. (France)

7793 (EUR-4872) CONTAMINATION OF PASTURES BY ^{131}I. PART I. RATE OF DEPOSITION OF ^{131}I. Angeletti, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1972. 26p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 40,-.

A reference to the origin and a number of physical properties of iodine-131 and the most important method of studying internal contamination of man is followed by the presentation of various physical and empirical models used for estimating the transfer of radioiodine from the air to the soil. Experimental results are reported relating to the rates of deposit cited in the literature. (auth)

7794 ^{137}Cs IN HUMANS: A RELATIONSHIP TO MILK ^{137}Cs CONTENT. Lloyd, R. D.; Pendleton, R. C.; Clark, D. O.; Mays, C. W.; Goates, G. B. (Univ. of Utah, Salt Lake City). Health Phys.; 24: No. 1, 23-36(Jan 1973).

A model was developed that relates the ^{137}Cs in humans to the ^{137}Cs in their milk supply. The data on which the model was based included periodic measurements of fallout ^{137}Cs in residents of 19 Utah dairy farms during the years 1962 through 1966 and in monthly collections of milk produced on these 19 farms over the same period of time. Extension of the model to residents of nine North American cities indicated its applicability to other similar populations. Appropriate adaptations could prove to be of utility in the prospective or retrospective projection of human ^{137}Cs body burdens produced by contaminating nuclear events for which estimates of ^{137}Cs in milk are available by model or by measurement. (auth)

7795 SEBEACH: A DIGITAL COMPUTER PROGRAM FOR THE ESTIMATION OF BODY CONTENT OF PLUTONIUM FROM URINE DATA. Beach, S. A. (National Radiological Protection Board, Harwell, Eng.). Health Phys.; 24: No. 1, 9-16(Jan 1973).

A formula is presented which relates the amount of plutonium found in a 24-hr urine sample, U(t), at a time, t, after intake, to the amount retained in the body. Due to the uncertainty of any single urine value, the method used is based upon the trend of the urine values. Two types of computation are carried out: first, as an upper limit, the calculated trend value is assumed to result from a single intake during the earliest possible period indicated by the urine record; second, the trend value is assumed to result from a constant and continuous intake over the whole exposed period. Two values are assigned to the index, b, in the above expression, to cover two different clearance rates from the lung or wound to the blood. The difficulties encountered in estimating the body content of plutonium are discussed in the light of the method of estimation programmed in SEBEACH. Comparison is made with other digital programs undertaking the same type of computation. A flow chart of the program is included. (UK)

7796 UPTAKE OF ^{67}Ga IN MALIGNANT TUMOURS. Barker, J. R.; Lavender, J. P.; Burn, I. (North Staffordshire Royal Infirmary, Stoke-on-Trent, Eng.). Brit. Med. J.; 4: No. 5836, 367(11 Nov 1972).

In 83 malignant tumors studied in vivo, ^{67}Ga concentrated preferentially in 48. It concentrated best in rapidly growing, poorly differentiated tumors. It also localized in nonmalignant inflammatory tissues, (an example is cited from a study of a series of advanced carcinomas of the breast). It is suggested in this brief note that preferential concentration in inflammatory tissues may be of particular importance when scanning for neoplasms of the large bowel. (UK)

7797 TKANEVODOZIMETRICHESKIE KHARAKTERISTIKI OSNOVNYKH RADIOAKTIVNYKH IZOTOPOV. SPRAVOCHNIK. (Tissue-Dosimetric Characteristics of the Principal Radioactive Isotopes. A Handbook). Shamov, V. P. Moscow; Atomizdat (1972). 129p.

Fundamental data and characteristic distribution data for the various organs and tissues of man provide information for evaluating the absorbed radiation dose following the uptake of the most widely known radioisotopes by man. This compact assemblage of graphs, formulas, equations, and data tables includes methods of calculating the radiation dose characteristic of various isotopes, dosimetry of the gastro-intestinal tract, and tissue-dosimetric characteristics for inhalation uptake of radioactive isotopes. Nearly two pages of pertinent data and physical constants are provided for the most important radioisotope of H, C, Na, P, S, Cl, Cr, Mn, Fe, Co, Zn, Sr, I, Cs, Ba, Po, and Ra. (90 references) (K.S.W.)

7798 RADIATION EXPOSURE OF THE ADJOINING ORGANS IN CONTACT THERAPY OF THE FEMAL GENITAL CARCINOMA USING VARIOUS RADIUM APPLICATORS. van der Wall, H. Zentralbl. Gynaekol.; 94: 123-33(29 Jan 1972). (In German).

Dose distribution in gynecological radiation contact therapy using radium-226 γ sources was studied. Depending on size and shape of the radioapplicator, the dose to rectum and bladder varied considerably. Even for the same types of sources, wide variations of radiation doses were found between patients. The scattering factor was considerably higher than that reported in the literature. Dose monitoring with an ionization chamber is considered mandatory. (H.B.G.)

7799 GENETIC AND CYTOGENETIC HAZARDS OF ENVIRONMENTAL POLLUTION. Leonard, A. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Ann. Gembloux; 78: 1-15 (1972).

The principal experimental results concerning the possible mutagenicity of various agents, including fallout radioisotopes, found in the human environment are summarized. The review of the literature shows that many of these agents have mutagenic properties in different test systems (microorganisms, plants, insects, or mammals). Variations in response are often noted from one system to another. Nevertheless, it is obvious that a positive response in any test system suggests always a potential genetic hazard. (auth)

7800 CORRECTION IN THE COMPARISON OF ^{210}Pb SKELETAL LEVELS WITH RADON DAUGHTER EXPOSURES. Wagner, W. L. (National Inst. for Occupational Safety and Health, Salt Lake City); Archer, V. E.; Blanchard, R. L. Health Phys.; 23: No. 6, 871-2(Dec 1972).

An error in the adjustment of the ^{210}Pb data for excretion and decay given in the article "Blood and Skeletal Levels of ^{210}Pb–^{210}Po as a Measure of Exposure to Inhaled Radon Daughter Products," Blanchard, R. L.; Archer, V. E.; Saccomanno, G. (Health Phys.; 16: 585(1969)) is discussed. As a consequence of adjusting exposure data on the basis of ^{210}Pb excretion and decay to the end of mining, and similarly adjusting bone ^{210}Pb concentrations for the time lapse between end of mining and death, the fast component of the ^{210}Pb excretion (88 days) was incorrectly used twice. This approach resulted in an incorrectly large adjustment for ^{210}Pb excretion since the rapid excretion will occur only during the period immediately following exposure. The correct method of treating the data is to adjust exposure to the time of death rather than to the end of mining and compare this value to the ^{210}Pb bone concentrations at death. Revised data are presented. (UK)

7801 MAXIMUM PERMISSIBLE CONCENTRATION OF ^{239}Pu IN AIR. Hamard, J. (CEN, Fontenay-aux-Roses, France). Radioprotection; 7: No. 2, 103-11(1972). (In French).

The radiotoxicity of Pu depends upon the way in which it penetrates the organism, its physical properties, and the way in which it is metabolized. The maximum permissible concentration of Pu in air is defined together with the health physics measurements made. Models are presented for studying the depositing in the respiratory tract: the ICRP model (1959); the Morrow respiratory model (1966). The currently used soluble and insoluble Pu compounds are divided into three classes according to whether they are retained for a short (days), average (weeks), or long (years) period of time in the organism. (France)

7802 TRANSFER FACTOR IN AIR ENCOUNTERED WHEN REMOVING RADIOPROTECTIVE CLOTHING. Scheidhauer, J.; Matevet, C. (Centre de La Hague, Cherbourg, France). Radioprotection; 7: No. 2, 77-85(1972). (In French).

A small amount of contamination occurs when radioprotection clothing is removed. A system simulating the removal of clothing in an enclosure constructed of polyvinyl chloride was developed. The factor representing the degree of resuspension of fission products and Pu from contaminated clothing (ratio between the activity in curies deposited on 1 m^2 of clothing and the activity resuspended in 1 m^3 of air) was determined. The contamination was produced with a wet source (solution of fission products), a dry source (plate contaminated with fission products) or from dusts contaminated with fission products containing Pu. In this way, the permissible limits concerning the contamination of clothing were deduced as a function of the MPC. (France)

7803 IMPACT OF ARTIFICIAL RADIOACTIVITY ON THE OCEANS AND ON OCEANOGRAPHY. Preston, A.; Woodhead, D. S.; Mitchell, N. T.; Pentreath, R. J. (Ministry of Agriculture,

Fisheries and Food, Lowestoft, Eng.). Proc. Roy. Soc. Edinburgh, Sect. B; 72: No. 41, 411-23(1971).

A review is presented of the impact of artificial radioactivity on oceans with emphasis on public health problems. Sources of artificial radioactivity in oceans are discussed and an inventory of radionuclides from nuclear explosion fallout, reactor waste disposal, and wastes from the reprocessing of fuel is presented. The impact of radioisotopes as a pollutant is discussed under the headings: man and the control of waste disposal; critical path approach for evaluating environmental capacity; significance of present activity levels; and damage to fish and other resources. The impact on oceanographic research is discussed with regard to physical, chemical, and biological oceanography. (H.L.W.)

7804 RISK OF INCORPORATION AND EXPERIENCES AT WORKING PLACES USING SEALED SOURCES. Gacs, F. (Fovarosi Kozegeszsegugyi es Jarvanyugyi Allomas, Budapest); Lendvay, J.; Predmerszky, T. Izotoptechnika; 15: No. 6, 330-3(Jun 1972). (In Hungarian).

Propositions on the estimation of incorporation risk based on radiotoxicity, activity, emitted radiation, and physical consistency of the sources are discussed. (auth)

7805 NEW FACTORS TO CALCULATE INTERNAL RADIATION RISK MODIFYING ASPECTS IN THE DESIGN AND CONTROL OF LABORATORIES. Roka, O. (Orszagos Frederic Joliot-Curie Sugarbiologiai es Sugaregeszsegugyi Kutato Intezet, Budapest); Predmerszky, T.; Lendvay, J.; Gacs, F. Izotoptechnika; 15: No. 6, 334-9(Jun 1972). (In Hungarian).

A suggestion for a new, versatile classification of isotope working areas is discussed. (auth)

7806 INTERNAL CONTAMINATION MONITORING EXPERIENCES IN THE ISOTOPE PRODUCTION HOT LABORATORY OF THE INSTITUTE OF ISOTOPES. Golder, F.; Uchrin, Gy.; Biro, T. (MTA Izotop Intezete, Budapest). Izotoptechnika; 15: No. 6, 340-4(Jun 1972). (In Hungarian).

The monitoring system for internal contamination applied at the Institute of Isotopes of the Hungarian Academy of Sciences is described. (auth)

Animals

7807 (COO-2003-16) FALLOUT ^{54}Mn ACCUMULATED BY BAY SCALLOPS ARGOPECTEN IRRADIANS (LAMARCK) NEAR BEAUFORT, NORTH CAROLINA. Schelske, C. L. (Michigan Univ., Ann Arbor. Great Lakes Research Div.). 1972. 23p. (CONF-720708-12; SM-158-20). Dep. NTIS.

From Symposium on the interaction of radioactive contaminants with the constituents of the marine environment; Seattle, WA. (10 Jul 1972).

Bay scallops were collected in estuarine waters near Beaufort, North Carolina, during the period of January 1963 to June 1966 and analyzed for gamma radioactivity originating from fallout. Most of the gamma radioactivity was ^{54}Mn, with scallops containing 30 times more ^{54}Mn than other lamellibranch mollusks collected at the same time. Concentrations of ^{54}Mn were largest in December 1963 and October 1964 and declined after October 1964, with a half-life of approximately 240 days. Concentrations of ^{54}Mn in the 75 samples collected were a function of collection sites in the estuary, size of the scallops, and tissue type. Amounts of ^{54}Mn were determined in seven different tissues. Kidneys contained the greatest concentrations, about 100 times more than adductor muscle, gills, mantle, gonad, visceral mass, and liquid. Maximum concentrations in kidneys were 100 pCi/g wet weight. Kidneys are a small fraction of the total weight, so concentrations in the combined soft parts are about a factor of 100 lower than the kidney. Stable element content of scallop tissues was determined also, and kidneys again contained at least 100 times more stable manganese than any of the other tissues. Variations in specific activities (pCi ^{54}Mn/μg Mn) among the different tissues were greater than could be explained by physical decay and possible turnover rates in the organism. Mechanisms of ^{54}Mn and stable manganese accumulation are postulated from data on specific activity of different tissues, mode of scallop feeding, and results of laboratory experiments in which scallops were fed phytoplankton labeled with ^{54}Mn. These data are important because kidneys of bay scallops concentrate ^{54}Mn more than any other biological system presently known. Public health implications are minimized because only the adductor muscle is sold as seafood. (auth)

7808 USKORENIE VYVEDENIYA IZ ORGANIZMA RADIOAKTIVNYKH IZOTOPOV. (Acceleration of the Excretion of Radioactive Isotopes from the Organism). Kobal, Yu. F. Moscow; Atomizdat (1972). 200p.

Methods are discussed for hastening the processes of removal of inhaled or ingested radioactive isotopes from the body. The methods include isotopic dilution, ionic antagonism, phlebotomy and blood transfusion, hemodialysis, complex formation, and the stimulation of urine secretion. The elimination of specific isotopes is discussed in detail: Cs, Sr, Ba, Y, rare earth elements, Zr, Nb, Mo, Te, I, and Ru. (512 references) (K.S.W.)

7809 LACTIC AND α-HYDROXYBUTYRIC ISOENZYMES IN THE KIDNEY AND PLASMA OF RATS POISONED WITH URANYL NITRATE. Villie, F.; Boyer, J. B.; Bastide, J.; Bastide, P. (Univ., Clermont-Ferrand, France). Compt. Rend. Soc. Biol.; 165: No. 12, 2358-60(1971). (In French).

Zymograms effected with lactate and sodium α-hydroxybutyrate exhibit identical variations during uranyl nitrate poisoning. A reduction in all the renal isoenzymes occurs. The most marked variations appear in the plasma; after 24 hrs type 1 and type 2 enzymes, which are not present in the normal state, manifest themselves. The isoenzymes are most probably of renal origin. (France)

7810 SPECIAL CAGE FOR A LONG-TERM KEEPING OF SMALL LABORATORY ANIMALS WITH INCORPORATED RADIONUCLIDES. Kofranek, V.; Taborik, J. (Institut Hygieny a Epidemiologie, Prague). Zdrav. Tech. Vzduchotech.; 15: No. 2, 71-4(1972). (In Czech).

A special unit is described where small laboratory animals that were administered radioactive substances with gaseous daughters can be permanently kept. The unit meets the requirements for closed, ventilated cages where a large number of experimental animals can be kept while all safety regulations are observed relating to installations handling radioactive substances (the Czechoslovak standard ČSN 34 1730). The unit does not require much room and is not expensive. (IMS)

7811 COMPARATIVE EFFECTS OF POTASSIUM, ACETAZOLAMIDE, FUROSEMIDE, THYROTROPIN, AND THYROXIN ON ^{137}Cs RETENTION IN THE RAT. Chertok, R. J.; Lake, S. (Univ. of California, Livermore). Health Phys.; 24: No. 1, 43-52(Jan 1973).

The effects of potassium ion, acetazolamide (Diamox), furosemide (Lasix) and desiccated thyroid on the retention and excretion of cesium have been studied by several groups because of the physiochemical similarity of the potassium and cesium ions. Some of these experiments were repeated with potassium, acetazolamide and furosemide and extended to include thyrotropin (TSH) and thyroxin in order to compare directly their effects on the retention, urinary excretion, and organ distribution of ^{137}Cs in the rat. Thyroxin (0.5 mg daily) given in conjunction with acetazolamide (30 mg daily) plus K^+ was the most effective of all the treatments in lowering the $R_{\frac{1}{2}}$ (time required for whole-body retention to be reduced to 50%) of ^{137}Cs; the $R_{\frac{1}{2}}$ was lowered from the control value of 8.5 to 4.7 days. Only one treatment effected an important increase in the rate of urinary excretion of ^{137}Cs after the first day: acetazolamide plus K^+ (total urinary excretion 63.6% of the total dose). Thyroxin (40.5% total urinary excretion when given alone) modified the renal effects of K^+ plus acetazolamide; hence, it would appear that only acetazolamide (48.8% alone) or K^+ (48.2% alone) is effective when all three are given together (49.7%). None of the treatments caused any important change in the organ distribution of ^{137}Cs. It was most concentrated in the muscle followed in order by submaxillary gland, kidney, heart, liver, brain or spleen, lung, bone, and blood. With respect to the tissue/blood ratios, although there were some significant differences from the controls, the lowered blood values in many cases caused the ratios to be high even when the total amount in the organ was lower than in the controls. (auth)

Plants

7812 TRITIATED WATER MOVEMENT IN SEMICONFINED GROWTH SYSTEMS. Klobe, W. D. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-GEN-242. J. Environ. Qual.; 1: No. 2, 189-92(1972).

Since its beta radiation will not penetrate the skin, the major hazard of tritium (^{3}H) to man is via the food pathways. This investigation was designed to provide preliminary information on ^{3}H behavior in the food pathways, which include soils and plants. Each of six semi-confined growth systems contained four corn (Zea mays L.) plants grown on 0.1 m^3 of a fertilized peat-sand-perlite mixture. The bottom of each container and the surface of the growth medium were covered with plastic to prevent excessive loss of ^{3}H due to evaporation or mass flow. The growth medium in each system received a single surface application of 3 mCi of tritiated water (HTO), and was kept near field capacity by watering every 2 or 3 days. Pairs of systems were labeled at 7, 10, or 13 weeks maturation of the corn, and the rate of ^{3}H

removal at different stages of plant growth was determined. Residence time of ^{3}H in the growth medium was short. At maximum rates of withdrawal (transpiration), over 90% of the added ^{3}H was removed within 1 week. The maximum amount of readily extractable ^{3}H found in the plants was about 3% of the original application. This occurred 3 days after labeling and decreased to 0.1 to 0.3% in 2 weeks. (auth)

New Tracer Techniques

7813 NEW RADIOTRACER TECHNIQUE INVOLVING ^{14}C AND ^{51}Cr, FOR ESTIMATING THE ASSIMILATION EFFICIENCIES OF AQUATIC, PRIMARY CONSUMERS. Calow, P.; Fletcher, C. R. (Univ. of Leeds, Eng.). Oecologia (Berlin); 9: No. 2, 155-70(1972).

Gravimetric, radiotracer, and indicator methods currently available for estimating assimilation efficiencies have been reviewed and their limitations have been discussed. It was concluded that the basic assumption implicit to gravimetric and indicator techniques, i.e. that all material contained within the faeces is derived from the food, does not generally hold. Radiotracer techniques are not based on this assumption but are time consuming. Consequently a new radiotracer technique analogous to indicator methods has been developed. In this technique the concentration of a non-absorbed indicator is expressed in terms of a radiotracer, ^{14}C, which can be absorbed but which, at least initially, is only present in the food, rather than expressing it in terms of dry weight. Chromium-51 has been used as the non-absorbed indicator. Use of these two isotopes in conjunction not only enables a distinction to be made between faecal material derived from food and that derived from metabolic secretions, but also facilitates estimation of assimilation efficiencies from small samples of faeces only. The new technique requires simply measurement of the ratio $^{14}C : {}^{51}Cr$ in samples of both food and faeces. The applicability of conditions necessary for operation of the new technique has been tested on two species of freshwater gastropod, one feeding on epilithic algae, the other on bacteria, and its effectiveness has been tested by reference to results obtained from another, more conventional method involving ^{14}C only. (GF)

7814 PURITY AND STABILITY OF RADIOCHEMICAL TRACERS IN AUTORADIOGRAPHY. Evans, E. A. (Radiochemical Centre Ltd., Amersham, Eng.). J. Microscopy; 96: No. 2, 165-80(Oct 1972).

Much of the paper is concerned with tritium compounds which are particularly valuable and widely used for studies involving high resolution autoradiography. The physical (nuclear) properties of tritium, the low maximum beta energy (18 keV) of the radiation, and the high maximum specific activity (29 Ci/mg atom of hydrogen), makes tritium the ideal isotope for determining the precise localization of compounds, drugs and hormones, for example, in biological specimens. Refinements in autoradiographic techniques that were developed in recent years have permitted high sensitivity in the detection of the tracer. Reference is made to some of the problems that can arise using impure tracer compounds and their effects on the interpretation of autoradiographs. The methods for the determination of purity, for example chromatographic, isotope dilution analysis, autoradiographic, and spectroscopic methods are discussed together with some of the difficulties associated with these analytical techniques. The instability of radiochemicals on storage prior to their use is now a well documented phenomenon. Factors that determine the rate of self-decomposition are discussed, such as the molar specific activity of the compounds, the energy of the radiation and the storage conditions selected for the compound. Current methods for minimizing self-decomposition of radiochemicals are discussed and illustrated by examples. Many of the methods used for the preparation of tritium compounds can yield products in which the specificity of the labeling is uncertain. The importance of the specificity of labeling in such tracers in relation to the interpretation of autoradiographic data is therefore also discussed. (auth)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 7497, 7512, 7514, 7900, 8896, 8928, and 8950.

7815 (AAEC/LIB/Bib-333) ZIRCONIUM–URANIUM OXIDE SYSTEMS WITH OR WITHOUT CALCIUM. A Bibliography. Geue, J. (comp.) (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1972. 35p. INIS.

Two hundred and seventeen references are listed covering the period 1962 to 1971. Reference to an abstract is made for each citation. The citations are listed alphabetically by author within each year. (INIS)

7816 (MLM–1969) PRODUCTION PROCESS FOR MOLYBDENUM COATING OF $^{238}PuO_2$. Jaeger, R. R.; Cohen, S. T.; Egleston, E. E.; Deal, W. R. (Mound Lab., Miamisburg, Ohio). 18 Nov 1972. Contract AT-33-1-GEN-53. 10p. Dep. NTIS.

A process for coating $^{238}PuO_2$ particles with molybdenum is described in detail. The process is based on the hydrogen reduction of $MoCl_5$ in a fluid-bed reactor. $MoCl_5$ was chosen over MoF_6 because of the increased neutron flux which results from any fluoride impurity due to the $^{19}F(\alpha,n)^{22}Na$ reaction. (auth)

7817 (ORNL–4503(Vol.4)) THORIUM CERAMICS DATA MANUAL. VOLUME IV. BORIDES. Peterson, Sigfred (Oak Ridge National Lab., Tenn.). 1971. Contract W-7405-eng-26. 13p. Dep. NTIS.

Physical, chemical, and mechanical properties of thorium borides, alone and in combination with other borides, are compiled from the literature through November 1971. The compounds ThB_4 and ThB_6 and the solid solutions $(Th,U)B_4$ are reasonably well characterized, although there are many gaps in the property data. Higher borides and boride-carbides are briefly described. (30 references). (auth)

7818 (RISO–269) IN-REACTOR DETERMINATION OF THE THERMAL CONDUCTIVITY OF UO_2-PELLETS UP TO 2200°C. Fayl, G.; Hansen, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1972. 35p. Dep. NTIS (U. S. Sales Only).

The thermal conductivity of sintered stoichiometric UO_2-pellets was determined in the temperature range 500 to 2200°C and at different burnup levels from 0 to 0.8×10^{20} fiss/cm^3. The conductivity was evaluated from temperature measurements at the center and two off-center positions in the UO_2-pellets. The power was determined by thermocouples measuring temperature differences in the heat conduction path out from the UO_2-pellets. These thermocouples were power-calibrated by means of an electric furnace. The rig design makes it possible to replace the centrally positioned thermocouple (during reactor shut-down) in the event of thermocouple failure to eliminate irradiation-induced changes in its emf-characteristic. Furthermore, it is possible to replace the gases in the fuel capsule in order to investigate the influence of fission gases on the fuel to cladding heat transfer. The experiment showed: (1) good agreement with literature data on thermal conductivity of UO_2 early in the irradiation (burnup $\approx 10^{19}$ fiss/cm^3); (2) a reduction in the thermal conductivity with burnup, at temperatures below 1000°C. This reduction caused a 9% increase of center fuel temperature at a linear heat rating of 350 W/cm, after 0.8×10^{20} fiss/cm^3; (3) no influence of burnup on the thermal conductivity above 1000°C; and (4) no influence of fission gases on the fuel to cladding heat transfer (initial gap = 0.57% of fuel diameter). With regard to the rig design, the system for exchange of the central thermocouple seems to be limited to a maximum fuel temperature of 1400°C. (auth)

7819 MOLECULAR STRUCTURE OF RHENIUM OXIDE. Vinogradov, V. S.; Ugarov, V. V.; Rambidi, N. G. (Inst. of High Temperatures, Moscow). Zh. Strukt. Khim.; 13: No. 4, 715-16 1972). (In Russian).

The compound Re_2O_7 contains two tetrahedral groups ReO_4 united by a bridge oxygen atom: Re–O–Re, with the distance between the two Re atoms = 3.58 Å and the angle Re–O–Re = 165°. Some doubt is cast on the claim that considerable similarity exists between Re_2O_7 and Cl_2O_7. (K.S.W.)

7820 CASTING HYDRIDES. Phillips, E. C. Jr. U. S. Patent 3,692,888. 19 Sep 1972. Filed 2 Jul 1969.

A method of casting lithium hydride, lithium deuteride, or lithium tritide, or mixtures of these with zirconium hydride in a titanium or titanium-coated mold under a hydrogen atmosphere exceeding the dissociation pressure of titanium hydride is described. Upon cooling, the cast material can be readily removed from the mold without damage. (Official Gazette)

7821 CONTROLLED CALCINATION OF AGGLOMERATED NUCLEAR FUEL PRIOR TO PELLETIZING AND SINTERING. Flipot, A. J. P. (to Belgonucleaire SA). U. S. Patent 3,692,887. 19 Sep 1972. Priority date 21 Dec 1967, Belgium.

A manufacturing method for sintered nuclear reactor fuel pellets exhibiting improved density reproducibility in which the fabrication procedure includes thermal deactivation at 600 to 1000°C for a controlled time of the fuel after an initial agglomeration step but prior to pelletizing, followed by an optional addition of a pressing lubricant, pelletizing, and sintering to about 1600°C or above is described. The thermal deactivation step reduces the amount of shrinkage encountered in the sintering step as compared with conventional techniques resulting in good dimensional characteristics and density uniformity. (Official Gazette)

7822 TEMPERATURE DEPENDENCE OF URANIUM CARBIDE FISSION-GAS SWELLING: AN ANALYTICAL EVALUATION. Markworth, A. J. (Battelle Memorial Inst., Columbus, OH). Contract W-7405-eng-92. Nucl. Sci. Eng.; 49: No. 4, 506-7(Dec 1972).

A simple model for the gas-diffusion-controlled growth of stationary gas bubbles in an isothermal solid, under constant rate of gas generation, is used to evaluate the temperature dependence of fission-gas swelling in uranium monocarbide. Using experimental data for the temperature-dependent volume diffusivity of xenon in uranium carbide, it is found that the predicted temperature at which the onset of fission-gas swelling occurs, evaluated at a given fission density, correlates relatively well with swelling data and is of the order of one-half the absolute melting point. Variations of bubble concentration and gas-generation rate are found to affect this predicted swelling-onset temperature only to a relatively slight extent. (auth)

7823 FUNDAMENTAL INVESTIGATIONS OF SINTERING REACTIONS OF (URANIUM–PLUTONIUM) CARBIDE. Krauth, A.; Mueller, N.; Neumann, G. (NUKEM GmbH, Wolfgang, Ger.). J. Nucl. Mater.; 45: No. 2, 163-70(Nov 1972). (In German).

A method for the preparation of (U, Pu) C pellets through sintering reactions was developed in regard to high-capacity fuel for fast breeders. By this method, a mixture of mixable, pressable, and sinterable UC powder with partially reacted fuel oxide–carbon mixture was cold pressed and sintered, during which the later addition of PuO_2 was simulated by UO_2. For pellet densities up to 90% theoretical, the mixture must be reacted partially at 1300°C. The possible advantage of this preparation method for (U, Pu) C pellets lies in the reduced preparation cost, reduced Pu losses, and increased product purity. Simultaneous running of carbide synthesis and sintering shrinkage can be accomplished, but at a disadvantage. (tr-auth)

7824 RE-SOLUTION EFFECTS AND FISSION GAS SWELLING IN UO_2. Dollins, C. C.; Ocken, H. (Bettis Atomic Power Lab., Pittsburgh). J. Nucl. Mater.; 45: No. 2, 150-62(Nov 1972).

A fission gas swelling model is proposed which enables one to calculate swelling in the vicinity of grain-boundary networks and in imperfection-free regions. The grain-boundary swelling requires a knowledge of the gas accumulation and the reaction rate at the boundary. The gas accumulation was calculated by deriving a modified form of Fick's second law wherein it was assumed that because of re-solution effects the in-pile diffusion coefficient can be described as a function of the gas concentration but is independent of the actual operating time. Reaction rates for bubbles at grain boundaries were derived in the manner discussed by de Jong and Koehler in their treatment of vacancy clustering. The results indicate that there is a grain size of about 10^{-4} cm for which the swelling is a maximum, which increases somewhat with irradiation temperature and with depletion at a constant temperature. The results enable one to predict the swelling and the mean radii of both intergranular and intragranular bubbles. Mean bubble radii predicted using the re-solution swelling model are in reasonable agreement with radii obtained from electron micrographs of irradiated UO_2 fuel samples. It is argued that gas bubble migration is the predominant means by which gas atoms arrive at grain boundaries at irradiation temperatures above about 900°C. (auth)

7825 SOLID-STATE RELATIONSHIPS IN THE SYSTEMS U–Se AND U–Se–C. Breeze, E. W.; Brett, N. H. (Univ. of Sheffield, Eng.). J. Nucl. Mater.; 45: No. 2, 131-8(Nov 1972).

Investigations were carried out, in argon and vacuum atmospheres, on phase equilibria in the U–Se–C system and compounds within the U–Se system were identified and their crystallographic data are given. A ternary diagram showing solid-state relationships in the U–Se–C system at 600°C is presented. The effects due to oxygen contamination of compositions within the ternary system are assessed and compatibility relationships in the U–O–Se and U–O–Se–C systems are discussed. (auth)

7826 ACTINIDE DIFFUSION IN URANIUM MONOCARBIDE. Hirsch, H. J.; Scherff, H. L. (EURATOM-CCR, Ispra, Italy). J. Nucl. Mater.; 45: No. 2, 123-30(Nov 1972).

Uranium self-diffusion was investigated in uranium carbide of controlled compositions, $UC_{1.07}$ and $UC_{0.96}$, within a temperature range between 1700 and 2300°C. The respective temperature functions are: $UC_{0.96}$: $D = 3.6 \times 10^{-2}$ exp [(–107 ± 3)/RT] for 1700°C < T < 2300°C; $UC_{1.07}$: $D = 4.0 \times 10^{-4}$ exp [(–106 ± 1.5)/RT] for 1700°C < T < 2050°C; and $D = 9.0 \times 10^{+2}$ exp [(–174 ± 6)/RT] for 2050°C < T < 2300°C. Comparative measurements of actinide diffusion (Pa, Pu, Am) in $UC_{1.07}$ yielded quite similar results, the deviations between the respective activation energies being within the range of experimental errors. From the change in activation energies in the hyperstoichiometric material at 2050°C it is concluded that the phase boundary between UC_{1+x} and β-UC_2 does not agree with the presently accepted U–C phase diagram. (auth)

7827 TRANSPORT KINETICS IN FACETED BUBBLES. Beere, W. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 45: No. 2, 91-5(Nov 1972).

A modified mechanism of bubble migration controlled by nucleation of atomic layers on bubble facets is presented and compared with the data for random migration of microscopic bubbles in neutron-irradiated UO_2. An expression is also derived for the velocity of directed motion under the action of a force and is applied directly to migration in temperature gradients. (auth)

7828 SINTERING OF GRAIN BOUNDARY CAVITIES IN URANIUM DIOXIDE. Burton, B.; Reynolds, G. L. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 45: No. 1, 10-14(Oct 1972).

The final-stage sintering of uranium dioxide was investigated in the temperature range 1623 to 1973°K where the residual porosity is situated mainly on grain boundaries. The shape of the sintering curve is quantitatively predicted from a knowledge of the cavity distribution and from the sintering rate of an individual cavity described by the Hull and Rimmer (1959) equation. The effective grain-boundary diffusion coefficient is estimated from these curves and is shown to be in reasonable agreement with the grain-boundary diffusion coefficient of uranium measured by radiotracer methods. The effect of entrapped gas appears to be of negligible importance since cavities were observed to sinter to closure; neither did grain growth strongly affect sintering rates, since cavities remained on grain boundaries. (auth)

7829 INTERNAL STRAIN OF UO_{2+x} INCLUDING U_4O_{9-y}. Domoto, K. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan); Igata, N. J. Nucl. Mater.; 45: No. 1, 87-90(Oct 1972).

A study was made of the correlation between the internal strains from x-ray diffraction in two-phase UO_{2+x} and U_4O_{9-y} and the concentration of excess oxygen atoms (from internal friction). The specimens had compositions between $UO_{2.00}$ and $UO_{2.25}$. The effective strain was found to increase with the concentration of excess oxygen atoms. Some effective strain also results from the interaction between the phases, but this component is smaller than that of excess oxygen. (D.L.C.)

7830 EFFECT OF ULTRASONIC TREATMENT ON THE SINTERABILITY OF URANIUM DIOXIDE. Abdel-Azim, M. S. (Atomic Energy Commission, Cairo). J. Nucl. Mater.; 45: No. 1, 76-8(Oct 1972).

An attempt was made to raise the lattice activity by applying ultrasonic energy to the powders. Two different UO_2 powders were used; they were prepared from UNH and from ADU. Ultrasonic treatments were carried out at 300 kHz in a cleaning unit, and the extra fines produced by the treatments were removed. Ultrasonic treatment did not change the crystallite size, but the internal strain is increased. Isothermal sintering curves show that the ultrasonic treatment increases the densification dramatically.

7831 PHASE EQUILIBRIUM AND THERMODYNAMIC INVESTIGATIONS ON THE URANIUM–RHODIUM–CARBON SYSTEM. Holleck, H.; Kleykamp, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 45: No. 1, 47-54(Oct 1972). (In German).

The isothermal section at 1300°C of the U–Rh–C phase diagram was determined by examination of cast and sintered specimens. The ternary compound U_2RhC_2, which forms peritectically, is in equilibrium with UC, U_2C_3, C and URh_3C_x. The Gibbs energy of formation of the compounds URh_3 and URh_3C_x was determined by means of solid-state electrolytic cells, using CaF_2 as the electrolyte. It was established that $^fG^\circ_T\langle URh_3\rangle = -61370 - 1.1\ T$ (cal/mol), at 1000 to 1150°K, and $^fG^\circ_T\langle URh_3C_x\rangle = -57040 - 5.5\ T$ (cal/mol), 870 to 1100°K. The standard entropy of URh_3 and the Gibbs energy of formation of U_2RhC_3 were estimated. (auth)

7832 CESIUM MIGRATION IN SILICON CARBIDE. Coen, V.; Hausner, H.; Quataert, D. (CCR-EURATOM, Ispra, Italy). J. Nucl. Mater.; 45: No. 2, 96-104(Nov 1972).

Pyrolytic silicon carbide was exposed to cesium vapor at elevated temperatures and the distribution of the metal was examined by ion analysis. A strong influence of microstructural defects on the cesium migration was observed. Silicon carbide samples of different microstructure were investigated. Striations in the structure caused an enhanced diffusion of the cesium into the silicon carbide. (auth)

7833 PHASE RELATIONSHIPS IN THE TERNARY SYSTEM U–Ni–N. Guha, J. P. (Univ. of Ljubljana, Yugoslavia). J. Nucl. Mater.; 45: No. 1, 40-6(Oct 1972).

The phase equilibrium relationships in the ternary system U–Ni–N were investigated by heat treating various mixtures at temperatures between 1200°C and 1600°C in 1 atm argon and nitrogen and identifying the phases present by metallographic and x-ray methods. The results show that UN and Ni react to form compounds of U and Ni with evolution of nitrogen. At higher nitrogen pressures, the tie lines U_2N_3–Ni and U_2N_3–UNi_5 occur in the ternary system. A phase diagram showing solid-state compatibility relationships and tentative boundaries of primary phase field in liquidus surface is proposed. (auth)

7834 COATING MICROSPHERES WITH ZIRCONIUM CARBIDE. Ikawa, K.; Iwamoti, K. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 45: No. 1, 67-8(Oct 1972).

A process was developed in which Zr and C are simultaneously deposited from vapor species produced by the reaction between CH_3I and Zr sponge. A spouted-bed apparatus was used. Formation of ZrC on Al_2O_3 microspheres was confirmed by x-ray diffraction, and experimental results and parameters (including iodine efficiency) are tabulated for runs at 1100 and 1300°C. (D.L.C.)

7835 STOPPING POWER AND RANGE OF α-PARTICLES IN (U,Pu)C AND UC AND APPLICATION TO SELF-DIFFUSION MEASUREMENTS USING ALPHA-SPECTROSCOPY. Hirsch, H. J.; Matzke, Hj. (EURATOM, Karlsruhe, Ger.). J. Nucl. Mater.; 45: No. 1, 29-39(Oct 1972).

The stopping power, dE/dx, the range, R, and the energy straggling, $\langle\Delta E^2\rangle$, for α particles in UC and (U,Pu)C were measured in the energy range between 1 and 5 MeV using three different techniques: carbide layers of known thickness were evaporated on thin α sources; thin α sources were "embedded" into the bulk of diffusion samples and these were subsequently sectioned until the source again reached the surface; in both cases, the energy loss was measured α-spectroscopically; finally, spectra from carbide sources of infinite thickness were evaluated to deduce dE/dx values. The experimental values of the stopping power were essentially higher than expected from the Bethe–Bloch theory of stopping power and from the phenomenological approach due to Whaling, especially at lower energies. The differences between theory and experiment were attributed to the contributions of inner electrons and were used to deduce the s.c. shell corrections. The data were shown to be of extreme importance while evaluating α-spectroscopically self-diffusion coefficients. This statement, though valid for any substance, is particularly true for UC and (U,Pu)C since due to the pronounced dependence of vapor pressures on the carbon/metal ratio, the thin tracer sources conventionally used in diffusion studies tend to get embedded in the bulk due to preferential evaporation from one of the two samples constituting the diffusion couple. (auth)

7836 CALCULATIONS OF THE IN-PILE BEHAVIOR OF FISSION GAS IN OXIDE FUELS. Ronchi, C.; Matzke, Hj. (EURATOM, Karlsruhe, Ger.). J. Nucl. Mater.; 45: No. 1, 15-28(Oct 1972).

Model calculations on fission gas behavior and fuel swelling during reactor operation are presented. In its present form, the model allows us to quantitatively calculate the contribution of single gas atom diffusion to the overall fission gas behavior, a contribution which was previously frequently neglected. Thus, the model includes gas atom diffusion, precipitation into a con-

stant number of bubbles of variable size, multiple-fission-induced resolution of gas atoms from bubbles, and precipitation at grain boundaries which are regarded to be deep sinks. Numerical solutions are obtained for many different sets of parameters for typical irradiation conditions in both fast and thermal reactors. The equated quantities are the concentrations of gas in dynamical solution, in intragranular bubbles and at grain boundaries, as well as the local swelling rate. As a typical example, some calculations for a fast flux irradiation experiment (DS irradiation) with mixed (U, Pu) oxides are given which show that experimental swelling curves can be reasonably well predicted with acceptable parameters. Conversely, the comparison of calculations and experimental results can serve to better determine such important parameters as effective in-pile diffusion coefficients. In addition, the relative importance of gas bubble mobility and sweeping phenomena etc. can be evaluated in this way. (auth)

7837 TRANSMISSION ELECTRON MICROSCOPIC STUDIES OF TWIN STRUCTURE OF URANIUM DICARBIDE. Kurasawa, T. (Japan Atomic Energy Research Inst., Tokai); Shiozawa, K.; Nasu, S.; Kikuchi, T.; Uchida, Y. J. Nucl. Mater.; 45: No. 1, 63-6(Oct 1972).

$UC_{1.86}$ was prepared by arc melting. Optical microscopy of as-melted specimens showed a single phase and twinned domains, and transmission electron microscopy at 1000 kV showed microtwins in annealed specimens but not in as-melted specimens. These microtwins are alternately large and small, with a width ratio of 3. The microtwins are symmetrical about the $(1\bar{1}2)$ twinning plane, and the microtwin structure of UC_2 is identified to be a twin system of the type $\{112\}_{bct}$. (D.L.C.)

7838 FREEZE DRYING: A UNIQUE APPROACH TO THE SYNTHESIS OF ULTRAFINE POWDERS. Roehrig, F. K.; Wright, T. R. (Battelle Columbus Labs., OH). J. Vac. Sci. Technol.; 9: No. 6, 1368-72(1972).

The freeze-dry process and its application in the general area of inorganic materials synthesis are discussed. Details of the process are given as well as its capabilities for producing ultrafine powders such as Pb-10 vol% MgO, WC, and W_2C, ultrafine grained consolidated materials such as W-25 Re are shown. Also, the application of the process for producing dispersion-strengthened systems such as Cu–ThO_2 and Cu–W is discussed. (auth)

7839 SYNTHESIS AND FABRICATION OF HIGH-PURITY HAFNIUM NITRIDE AND HAFNIUM CARBIDE. Heestand, R. L. (Battelle Columbus Labs., OH). J. Vac. Sci. Technol.; 9: No. 6, 1365-7(1972).

The procedures used to prepare kilogram quantities of hafnium nitride and hafnium carbide powders and hot-pressed billets are described. In order to maintain high purity, all steps of the process were conducted in either a vacuum or a high purity atmosphere. Analyses conducted on the starting materials and at various stages of processing indicated that target impurity levels, i.e., less than 100 ppM oxygen, could not be attained but that high levels of contamination could be avoided. (auth)

7840 OPTICAL CONSTANTS, DENSITIES, COEFFICIENTS OF THERMAL EXPANSION, AND REFRACTIVE INDICES OF GLASSES IN THE SYSTEM SiO_2–B_2O_3–BaO–Al_2O_3. Shchavelev, O. S. J. Appl. Chem. USSR (Engl. Transl.); 45: No. 5, 1033-8 (May 1972).

Translated from Zh. Prikl. Khim.; 45: No. 5, 1005-12(May 1972).

A study of the dependence of the refractive indices, mean dispersion, and thermal coefficients of expansion and of the refractive index on the chemical composition of glasses of the system SiO_2–B_2O_3–BaO–Al_2O_3 in the composition region which forms the basis of optical glasses of the heavy crown type showed that the properties of glasses in this region undergo discrete changes at the phase boundaries. The method proposed for determination of the relative content of boric anhydride in tetrahedral form makes it possible to carry out fairly accurate calculations of the properties of high-barium borosilicate glasses. (auth)

7841 TERNARY SYSTEM PbO–GeO_2–WO_3. Bergman, A. G.; Machavariani, Z. N.; Mal'tsev, V. T. (Engineering-Construction Inst., Rostov-on-Don, USSR). Zh. Neorg. Khim.; 17: No. 11, 3106-10(Nov 1972). (In Russian).

The ternary system PbO–GeO_2–WO_3 was investigated with thermal and x-ray techniques. The field of initial crystallization of original components and compounds forming along two sides of the diagram was defined. A ternary compound congruently melting at 711°C and having the composition $15PbO \cdot 3GeO_2 \cdot 2WO_3$ was established. A significant area abutting the GeO_2–WO_3 side was characterized by liquation of the compositions. Those compositions rich in GeO_2 and lying close to the PbO–GeO_2 side tended to form glasses. (tr-auth)

7842 BINARY CONSTITUTION DIAGRAMS OF SYSTEMS COMPOSED OF VARIOUS ELEMENTS AND BORON. A REVIEW. Portnoi, K. I.; Romashov, V. M. (All-Union Scientific-Research Inst. of Aviation Materials, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 5, 378-84(May 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 5, 48-56(May 1972).

Experimental techniques used by the authors in studies of the phase diagrams of B with Zr, Hf, Ta, Cr, Mo, W, Re, Fe, Ni, and Si are described. Phase diagrams of all these systems (with the exception of Si) are presented, and the results are discussed. 44 references. (D.L.C.)

7843 VIBRATORY DENSIFICATION OF DISPERSION-TYPE FUEL ELEMENTS FOR NUCLEAR REACTORS. Zivanovic, B.; Mikijelj, V. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 5, 414-18(May 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 5, 93-9(May 1972).

Vibratory densification is examined from a geometric standpoint. Theoretical calculations are given of the distribution of particle sizes and weight proportions of individual fractions necessary for maximum density in tubular, annular, and "inversed" fuel elements as a result of vibratory densification. For the attainment of a high and uniform packing density, the ratios between the dimensions of the shell of the vessel and the diameter of the coarse-fraction particles, and also of the particle sizes of the remaining fractions are important. The particles of these fractions must fit the residual interstitial voids, whose distribution is not uniform even in tubular fuel elements. Measurements with a gamma-ray meter have demonstrated good agreement between actual and calculated axial density distributions. The process should make it possible to obtain, in some cases at any rate, the relatively uniform packing density that is required in the compaction of metal powder parts of complex configuration. (auth)

7844 INFLUENCE OF SOME FACTORS ON THE SHORT RANGE ORDER IN THE SOLID SOLUTION TiC–WC. Katsnel'son, A. A.; Gorbacheva, T. B.; Rybal'chenko, R. V. (Moscow State Univ.). Fiz. Metal. Metalloved.; 34: No. 1, 211-13(Jul 1972). (In Russian).

The role of various factors on short range ordering was elucidated in double carbides as a continuation of previous work by the same authors (1971). The original samples of solid solution of TiC–WC, after an investigation of short range ordering, were subjected to treatment at 2,150 to 2,200°C for one to two h, and then cooled in various ways. The diffusion scattering of x rays was studied as a function of the annealing conditions. The coefficients of short range order were calculated by the method of least squares for the first three coordinate spheres. Variations in these coefficients were recorded for the differently annealed samples and compared with the initial values. (K.S.W.)

7845 NUCLEAR FUEL MATERIALS. Peter, J.; Schumacher, H. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Chima (Aarau); 26: No. 10, 533-8(10 Oct 1972). (In German).

Discussed are various nuclear fuel materials with respect to melting points, density, and heat conduction. Production of ceramic nuclear fuel material is treated for oxides and carbides as well as for coated particles. Also discussed is the compatibility between nuclear fuel material and cladding as well as their behavior under irradiation. (H.B.G.)

7846 PREPARATION AND PROPERTIES OF CERMET FIBERS OF REFRACTORY COMPOUNDS AND MATERIALS ON THEIR BASE. Samsonov, G. V.; Matsera, V. E. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 42-7(Sep 1972). (In Russian).

A process for extrusion and sintering of fibers produced from refractory compounds (TiC, TiB_2, ZrB_2) is described, and their properties and some fields of application were investigated. The hydraulic properties of high-porous materials of cermet fibers of TiC were found to be close to filters of metal wire and by compression strength do not yield to porous materials of powders and probably surpass them in fineness of refinement. (auth)

7847 EFFECT OF HIGH-TEMPERATURE ANNEALING ON CHARACTERISTIC OF ZIRCONIUM CARBIDE DECOMPOSITION. Travushkin, G. G.; Bukatov, V. G. Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 63-4(Sep 1972). (In Russian).

The effect of annealing temperature on the diagram characteristics of polycrystalline zirconium carbide decomposition at indoor temperature was investigated. With an increase in annealing temperature from 2300 to 2700°C the process of forming properties in zirconium carbide is shown to be continued. (auth)

7848 SCIENCE OF CERAMIC MACHINING AND SURFACE FINISHING. Proceedings of a Symposium Held at Gaithersburg, Maryland, November 2–4, 1970. Schneider, S. J. Jr.; Rice, R. W. (eds.). National Bureau of Standards Special Publication 348. Washington, DC; National Bureau of Standards (1972). 433p. (NBS-SPEC.-PUBL-348; CONF-701155). GPO $5.25.

Thirty-six papers were presented at the symposium. A separate abstract was prepared for each of five papers that were in scope for NSA. (J.R.D.)

For abstracts of individual papers see: 7849–7853.

7849 SHAPING OR FIGURING CERAMIC SURFACES BY ION-BEAM BOMBARDMENT. Levy, P. W. (Brookhaven National Lab., Upton, NY). Nat. Bur. Stand. (U. S.), Spec. Publ.; No. 348; 155-69(1972).

From Science of ceramic machining and surface finishing symposium; Gaithersburg, MD (2 Nov 1970). See NBS-SPEC.-PUBL-348; CONF-701155.

The shaping or figuring of glass and ceramic surfaces by ion-beam erosion is a relatively new technique. All operations are carried out in a vacuum. Usually the optic is bombarded by a collimated beam of rare gas ions whose energy is 1 to 100 keV. Selected areas can be eroded by electrostatically deflecting the beam or, less conveniently, by moving the optic. The erosion area can be controlled by focusing the beam with electrostatic or magnetic lenses. The basis of the erosion process is the physical phenomenon known as sputtering. This occurs when the incident ions scatter elastically with atoms near the surface of the target and some of the displaced atoms, after participating in one or more collisions, acquire sufficient velocity to escape from the solid. Other dislodged atoms become interstitials and, together with vacancies created in the recoil process, create a radiation-damaged layer just below the eroding surface, whose thickness is roughly the range of the bombarding ions. For ceramic materials typical erosion rates are on the order of angstroms/μamp/cm^2/min and increase with increasing angle of incidence. Ion-beam currents up to 100 μamp cm^2 are practical. Under these conditions the material struck by the beam may reach temperatures between 300 and 700°C. The maximum lattice disruption occurs at a depth of one incident ion range from the original surface, just as the eroding surface reaches this point. Additional bombardment does not increase the damage beyond this maximum. Furthermore, the damage is minimized by using bombardment conditions which maximize the temperature in the target. It is not known if there are any radiation damage effects which reduce the usefulness of ion-beam figured optics. At the moment it would appear that ion-beam figuring is a practical technique for touching up conventional optics and, more importantly, for fabricating non-spherical or non-axially symmetrical optics. Also, the ion-beam erosion process is particularly amenable to computer control. (auth)

7850 EFFECT OF SPUTTERING ON SURFACE TOPOGRAPHY AND STRENGTH OF CERAMICS. Rice, R. W. (Naval Research Lab., Washington, DC). Nat. Bur. Stand. (U. S.), Spec. Publ.; No. 348, 171-87(1972).

From Science of ceramic machining and surface finishing symposium; Gaithersburg, MD (2 Nov 1970). See NBS-SPEC.-PUBL-348; CONF-701155.

The topography developed as a result of rf sputtering on a variety of ceramic surfaces is described showing that surface cracks, scratches, and pits are fairly rapidly rounded out. Generally, this occurs without differential grain boundary sputtering. However, some bodies develop a rough finish due to nonuniform microstructural removal. Limited trials with ion beam sputtering show it also rounds cracks, but does not develop a rough finish on bodies that will with rf sputtering. Because of the rounding of stress concentrating features and generally similar effects on single and polycrystalline bodies, sputtering was investigated as a substitute for flame polishing, but with much wider applicability. Flame polished strengths were not obtained. However, some materials (e.g., $MgAl_2O_4$) do show greater improvements in strengths than others (e.g., Al_2O_4) as a result of sputtering. These differences will be discussed and results compared with other methods of surface finish. Both the detailed nature of the sputtered surface as well as enhancement of grain boundaries and,other microstructural features under certain conditions can be taken as an indication that sputtering may also be useful as an etching technique. (auth)

7851 TECHNIQUES AND MECHANISMS OF CHEMICAL, ELECTROCHEMICAL, AND ELECTRICAL DISCHARGE MACHINING OF CERAMIC MATERIALS. Lee, D. W.; Feick, G. (Arthur D. Little, Inc., Cambridge, MA). Nat. Bur. Stand. (U. S.), Spec. Publ.; No. 348, 197-211(1972).

From Science of ceramic machining and surface finishing symposium, Gaithersburg, MD (2 Nov 1970). See NBS-SPEC.-PUBL-348; CONF-701155.

Electrochemical machining (ECM), electrical discharge machining (EDM), and chemical machining (CHM) techniques have not been extensively used as a material removal process for ceramics. The fact that these processes are not dependent upon the hardness of the workpiece should make them attractive for the shaping of ceramics. However, ECM and EDM techniques are limited to material with reasonably good electrical conductivity while CHM may be limited by the availability of effective etchants and the nature of the ceramic itself. The theory and techniques of chemical, electrochemical and electrical discharge processes are reviewed. The variables and important parameters of the material removal processes are discussed, including etchants and mask techniques for chemical milling; current-voltage characteristics, dielectric fluids, and electrode materials for EDM; electrolytes, gap effects, and current density for ECM. The available information and experiences developed on metals and alloys are used to examine the applications and limitations of these processes to ceramic materials. Where possible the effects of the material removal process on the surface condition, microstructure, and subsequent material properties are pointed out. Comments are included on the technical and economic feasibility of ECM, EDM, and CHM processes for the shaping, cutting, and finishing of crystalline ceramics. (auth)

7852 ASSESSMENT OF SURFACE AND SUBSURFACE DAMAGE INTRODUCED IN CERAMICS BY SEMIFINISH GRINDING OPERATIONS. Koepke, B. G. (Honeywell Corporate Research Center, Hopkins, MN). Nat. Bur. Stand. (U. S.), Spec. Publ.; No. 348, 317-32(1972).

From Science of ceramic machining and surface finishing symposium; Gaithersburg, MD (2 Nov 1970). See NBS-SPEC.-PUBL-348; CONF-701155.

The nature and extent of damage introduced by surface grinding a number of ceramics having widely varying mechanical properties has been studied. Surface damage has been characterized by optical and electron microscopy and sub-surface damage has been observed using etch pit techniques. Grinding damage was found to depend strongly on wheel type and rate of material removal as well as on the mechanical behavior and microstructure of the workpiece. The results indicate that grinding damage is mainly composed of mixtures of three types depending on the mechanism of material removal. When material is removed efficiently from low impact resistance ceramics (e.g., magnesium oxide and ferrite) the surfaces are generated by brittle fracture and are composed of regions of transgranular and intergranular fracture. When grinding is inefficient; i.e., when the grinding wheel loads up, material is removed by plastic flow. The resultant surfaces on deformable ceramics (e.g., magnesium oxide, ferrite, and silicon) are smooth and burnished, but may contain thermal cracks due to the heat generated. In this instance subsurface damage consists of a discrete, highly deformed layer containing cracks in most cases. When material is removed efficiently from high impact resistance, non-deformable ceramics (e.g., alumina and boron carbide) material is removed by plastic flow and by transgranular and intergranular fracture. The presence of extensive plastically flowed regions on the ground surfaces of extremely hard ceramics is surprising and points out the extremes of stress and temperature existing under the wheel-workpiece interface during a grinding pass. (auth)

7853 EFFECT OF GRINDING DIRECTION ON THE STRENGTH OF CERAMICS. Rice, R. W. (Naval Research Lab., Washington, DC). Nat. Bur. Stand. (U. S.), Spec. Publ.; No. 348, 365-76(1972).

From Science of ceramic machining and surface finishing symposium; Gaithersburg, MD (2 Nov 1970). See NBS-SPEC.-PUBL-348; CONF-701155.

It is shown that grinding bars in a direction parallel with the tensile axis have limited effects on their strength, while grinding perpendicular to the tensile axis may have no effect or can reduce strengths as much as 50 percent. In single crystals, the reduction in strength generally increases with the hardness of the material, but can also depend on crystallographic orientation. In polycrystalline bodies, the reduction also depends a great deal on grain size, with the effect generally increasing with decreasing grain size. Also the effect tends to be greater in polycrystalline bodies that are weaker than normal. The effect of grinding direction on strength is attributed to stress concentrations due to grinding striae, whose continuity and depth generally increase with hardness. The severity of these striae tends to increase as the amount of plastic deformation in the machined surface decreases. The amount of plastic deformation is shown to vary approximately in-

versely with hardness. The effect of varying strength with grinding direction on the interpretation of various tests is discussed. (auth)

7854 SILICON OXYNITRIDE: A NEW CERAMIC MATERIAL FOR NUCLEAR APPLICATIONS. Keilholtz, G. W.; Moore, R. E. (Oak Ridge National Lab., TN). Nucl. Technol.; 16: No. 3, 566-7 (Dec 1972).

Silicon oxynitride, a relatively new ceramic that has desirable properties for applications in high-temperature nuclear reactors, was found to be resistant to gross damage and major dimensional changes during intense fast-neutron irradiation at temperatures from <100 to ~800°C. (auth)

7855 SMOOTHED VALUES OF THE ENTHALPY AND HEAT CAPACITY OF UO_2. Kerrisk, J. F.; Clifton, D. G. (Los Alamos Scientific Lab., NM). Nucl. Technol.; 16: No. 3, 531-5(Dec 1972).

UO_2 enthalpy data measured by five different investigators using drop calorimetry were fitted to a theoretically based equation from room temperature to the melting point. The equation can be used to calculate enthalpy, and differentiated to obtain heat capacity in this temperature range. Two of the constants in the equation are related to properties of the UO_2 lattice. (auth)

7856 ANNEALING BEHAVIOR OF NEUTRON-IRRADIATED SILICON CARBIDE TEMPERATURE MONITORS. Price, R. J. (Gulf General Atomic Co., San Diego, CA). Nucl. Technol.; 16: No. 3, 536-42(Dec 1972).

Hot-pressed α-silicon carbide temperature monitors were irradiated at 525 and 772°C to 4.8×10^{21} n/cm^2 (E > 0.18 MeV). Post-irradiation isochronal annealing was carried out for 1-h periods at either 25 or 50°C intervals between 300 and 1500°C. Above the irradiation temperature the sample length decreased linearly with annealing temperature, while the electrical resistivity increased exponentially with temperature. Straight lines were fitted through the length-versus-temperature and log (resistivity)-versus-temperature data points and the temperature, T_I, at which the line intersected the as-irradiated base line was measured. For both length change and resistivity, mean values of T_I agreed with the measured irradiation temperature within experimental accuracy. The precision of a single determination of T_I was obtained from curve-fitting statistics and was about ±20°C for irradiation at 525°C, and ±30°C at 772°C (90% confidence limits) for both length and resistivity measurements. The sample-to-sample reproducibility of T_I was estimated from the standard deviation of four repeated measurements and was similar to the precision of a single determination. (auth)

Metals and Alloys

7857 NIOBIUM AND NIOBIUM ALLOYS IN NUCLEAR POWER. Goldberg, D. C. (Westinghouse Astronuclear Lab., Pittsburgh); Dicker, G.; Worcester, S. A. Nucl. Eng. Des.; 22: No. 1, 95-123(1972).

Niobium and its alloys have been evaluated for a number of terrestrial and space nuclear powered systems. After a decade of research and development, many alloys have been developed which meet many of the requirements of long time, high temperature service. A remaining outstanding problem is their interaction with active gases and high purity coolants and other interstitials, even at low pressures, with resulting deleterious effect on their design properties. Careful design practice must be exercised to prevent this potential decrease in the desirable properties of niobium. (auth)

Corrosion and Erosion

Refer also to abstract 7558.

7858 (EURFNR-1017) SODIUM CORROSION TESTS ON X10 CrNiMoTi 15 15 STEEL (MATERIAL NO. 1.4970). Borgstedt, H. U.; Crechsler, G.; Frees, G.; Marin, A.; Schneider, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Mar 1972. 30p. (KFK-1574). Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Sheet specimens of the stainless steel Werkstoff-Nr. 1.4970 were exposed to flowing sodium at 0.5 m/s and 550 and 600°C for 5200 h. The oxygen content of the sodium was about 5 ppM. The specimens suffered weight losses and loss of thickness, which was calculated to be 04.5×10^{-6} cm/a at 600°C and 02.2×10^{-6} cm/a at 550°C. The corrosion rates decreased with the downstream length in the test section. The surface areas up to a depth of 10 μm showed changes of the composition, mainly in the concentrations of chromium and manganese. The carbon content of the material did not change under the test conditions. The concentration of boron, however, was decreased from an initial value of about 80 ppM to values of about 20 ppM. (auth)

7859 (ORNL-4829) INTERGRANULAR CRACKING OF INOR-8 IN THE MSRE. McCoy, H. E.; McNabb, B. (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 179p. Dep. NTIS.

The INOR-8 surveillance specimens and components from the MSRE that had been exposed to fuel salt formed shallow intergranular cracks (2 to 10 mils deep in exposures to greater than 20,000 h). Some of these cracks were visible in polished sections of as-removed materials, but many others were visible after the samples had been deformed. Considerable evidence indicated that the cracks were due to the inward diffusion of fission products. The fission product cracking mechanism was further substantiated by laboratory tests which clearly demonstrated that tellurium cases intergranular cracking in INOR-8. These tests have included other materials, and important variations exist in their respective susceptibilities to cracking by tellurium. Several materials, including types 300 and 400 stainless steels, nickel- and cobalt-base alloys containing greater than 15% Cr, copper, Monel, and INOR-8 containing 2% Nb, completely resisted cracking in the tests run thus far. (auth)

7860 (SC-RR-720757) OXIDATION OF MULBERRY ALLOY IN THE AGED $\alpha + \gamma_3$ STRUCTURE. Sallach, R. A.; Boultinghouse, K. D. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. 19p. Dep. NTIS.

The oxidation of Mulberry alloy (U-7.5wt%Nb-2.5wt%Zr) has been studied for the $(\alpha + \gamma_3)$ aged alloy structure at 200, 305, 400, and 500°C. At 305° and above, the oxygen consumption curves showed an unusual sigmoid characteristic and a rate which was proportional to $P_{O_2}^{1/4}$. An apparent activation energy of ~12 kcal was found. Metallographic observations on alloy structure and scanning electron photomicrographs of the oxide surface are also presented. (auth)

7861 STUDY OF CORROSION OF NICKEL-MOLYBDENUM ALLOY EP-496 IN HYDROCHLORIC ACID SOLUTIONS CONTAINING FLUORINE IONS. Matusevich, V. S.; Lebedev, A. N.; Fokin, M. N.; Konstantinova, E. V. Zashch. Metal.; 8: No. 3, 317-20(1972). (In Russian).

For purposes of selecting a corrosion-resistant material for highly corrosive media of the system HCl + HF + H_2O, nickel-molybdenum alloy EP-496 (C < 0.05, Si < 0.5, Mn < 0.5, V 1.4 to 1.7, Fe < 4.0, Mo 25 to 29 percent, the rest Ni), was tested. The tests were conducted in a 10 M HCl solution with additions of 0.2 to 1.0 M F^- at the boiling point (104°). Alloy EP-496 possessed satisfactory corrosion resistance in a hydrochloric acid solution with fluoride additions. The corrosion rate and potential changed slightly with the introduction of up to 1.0 M fluorine ion into the solution. The alloy corroded at an increased rate if there were oxidizing agents in the solution. The corrosion potential of EP-496 in a 10 M HCl + 0.2 M F^- solution shifts towards positive values and the average corrosion rate rose sharply with an increase in the Fe^{3+} concentration. For purposes of corrosion protection, a method of Fe^{3+} reduction in solution was tried, and the most effective reducing agents were selected. This treatment was found to be more effective with a homogeneous oxidation mechanism than with heterogeneous oxidation. The problem was to select a reagent which permits sufficiently rapid and complete reduction of Fe^{3+} with minimum consumption of the introduced reducing agent. Sodium hyposulfite and hypophosphite proved ineffective. The introduction of tin dichloride provided effective protection, reducing the corrosion rate to that in a solution free of an oxidizing agent. In experiments with metallic reducing agents, their protective effect on the alloy was eliminated (the experiments being staged in the absence of direct contact between specimen and the chip of the introduced metal). There was an increase in the corrosion rate of the alloy with the introduction of a metal chip (steel St. 3) into the solution. The transition of metallic iron to the ionic state was accompanied by intensive hydrogen evolution. Metallic aluminum cut in half the corrosion rate of the alloy. Metallic titanium was found to be an exceptionally effective corrosion inhibitor for alloy EP-496 in a hydrochloric acid-fluoride medium both in the presence and in the absence of trivalent iron ions in the solution. The optimum addition of metallic titanium for protection at certain oxidizing agent concentrations was chosen empirically. (JPRS)

7862 CORROSION RESISTANCE OF VACUUM CADMIUM AND TIN-CADMIUM COATINGS IN A 3 PERCENT NaCl SOLUTION. Khuntsariya, E. M.; Rafalovich, D. M.; Modzelevskii, A. A.; Bulitko, G. G.; Budyuk, L. F. (Inst. of Metallurgy,

Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 68: No. 2, 385-8(Nov 1972). (In Russian).

The corrosion protection properties of vacuum-cadmium and tin-cadmium coatings over plating in chloride solutions are discussed. Corrosive properties were obtained by loss of mass and by photographing the dynamic polarization curves of the potential. The application of 10 μ thickness coatings in chloride solutions is advised. A tin sublayer reduces the porosity of the coatings and the corrosion rate in a 3% solution of sodium chloride. (auth)

7863 FACTORS AFFECTING STRESS CORROSION CRACKING OF ZIRCALOY IN IODINE VAPOUR. Wood, J. C. (Chalk River Nuclear Labs., Ont.). J. Nucl. Mater.; 45: No. 2, 105-22 (Nov 1972).

Zircaloy stressed in tension may crack, predominantly transgranularly, in iodine vapor at temperatures commonly found in water-cooled reactor fuel sheaths (around 300°C). Since iodine in quite an abundant fission product and tensile stresses can arise in fuel sheaths due to thermal expansion of UO_2 fuel or fission gas pressure, a study was made of metallurgical and environmental variables that could affect cracking. These include applied stress, residual stress, crystallographic texture, cold work, irradiation history, catalysts, and iodine concentration. (auth)

7864 HYDROGEN SUPERCHARGING DURING CORROSION OF ZIRCALOY. Hillner, E.; Kass, J. N.; Kearns, J. J. (Bettis Atomic Power Lab., Pittsburgh). J. Nucl. Mater.; 45: No. 2, 175-8(Nov 1972).

It is shown that hydrogen supercharging during corrosion of Zircaloy can occur in the absence of thermal cycling. Two Zircaloy-4 coupons containing 10 ppM H were exposed to 1.0 N LiOH solutions at 316°C for 20 and 38 h, with only a single startup and shutdown. Analysis after exposure gave H contents of 232 and 509 ppM. Since the corrosion exposures were uninterrupted, Westlake and Ockers' cyclic supercharging mechanism could not apply. An alternative explanation is offered in which the capacity of the α phase to supersaturate in the presence of a hydride phase permits a diffusion gradient to exist in the α solid solution which produces isothermal precipitation. The results are fitted to Marino's equations. (D.L.C.)

7865 TRANSMISSION ELECTRON MICROSCOPY OF ION-THINNED OXIDES FORMED DURING CORROSION OF ZIRCALOY-4. Airey, G. P. (Westinghouse Research Lab., Brussels); Sabol, G. P. J. Nucl. Mater.; 45: No. 1, 60-2(Oct 1972).

An ion thinning technique was used to produce thin films from corrosion coupons that were in both the pre- and post-transition condition. The ion thinning was carried out in an Ion Micro Milling Instrument, using two guns on both sides of the oxide. Coupons with oxide film thicknesses of 1 to 6 μm could be treated this way to produce films for examination. Two structures were observed, a very fine grained structure (100 to 200 Å) and recrystallized areas. The recrystallized areas occurred in the post-transition regime, and contrast effects which may be caused by pores were detected in those areas. (D.L.C.)

7866 PREPARATION AND CORROSION PROPERTIES OF A TANTALUM SPUTTERED THICK FILM. Kashu, S.; Sano, T.; Hayashi, C. (Vacuum Metallurgical Co., Chiba, Japan). J. Vac. Sci. Technol.; 9: No. 6, 1399-1403(1972).

A tantalum sputtered film formed on the surface of stainless steel (AISI-316) has good corrosion resistance to hot sulphuric acid. Corrosion resistance of sputtered tantalum films, 6 to 20 μ thick is superior to that of other high quality corrosion resistant materials, such as niobium, titanium, zirconium, Hastelloy-B, and AISI-316 stainless steel. The corrosion rate of sputtered tantalum films is similar to that of 50 μ thick tantalum foil. Results of up to 1000 h corrosion tests, an adhesion strength test, and a bend test of the film are presented. (auth)

7867 INTER- AND TRANS-CRYSTAL FRACTURE OF STEELS AND ALLOYS SUBJECTED TO THE ACTION OF VARIOUS MEDIA (A SURVEY). Larikov, L. N.; Omel'yanenko, V. V. (Inst. of Metal Physics, Kiev). Metallofizika; No. 40, 3-24(1972). (In Russian).

The literature data in intercrystalline corrosion and corrosion resulting from stresses on constructional material are reviewed. Intercrystalline corrosion is caused by the presence of occluded particles of a second phase in nonhomogeneous solid solutions. The degree of order–disorder transformation in homogeneous solid solutions leads to an uneven increase in the general corrosion resistance, but does not eliminate the tendency to corrode under stress. The relationship between dislocated structure of a material and its tendency toward trans-crystal cracking under stress is described. Exemplifying some of the types of intermetalides discussed are: $TaAl_3$, $MoAl_3$, $ZrBe_{13}$, $NbBe_{12}$, $NbBe_{17}$, TiB_2, $BiCe_3$, $SnCe_2$, AlCe, BiCe, Al_2Ce, Bi_2Ce, Bi_3Ce_4, and Mg_3Ce. 132 references. (K.S.W.)

7868 CORROSION-RESISTANT METALLIC MATERIALS. Ishihara, Tadao; Shimizu, Yoshihiko. Chutanzo; 23: No. 10, 11-17(1970). (In Japanese).

Methods are suggested for improving the corrosion resistance of metals and alloys. The dependence of steel corrosion on contaminant content (P, S, Si, etc.) is considered and uniform, spot, and stress corrosion of Cu, Al, Ni, Ti, Pb, Zr, and their alloys are described. (Referativnyi Zh.)

7869 EFFECTS OF HOT-SALT STRESS CORROSION ON TITANIUM ALLOYS. Gray, H. R. (Lewis Research Center, Cleveland). Metals Eng. Quart.; 12: No. 4, 10-17(Nov 1972).

Susceptibility of titanium alloys to hot-salt stress-corrosion cracking increased in the following order: Ti-2Al-11Sn-5Zr-1Mo-0.2Si, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-4V, Ti-6Al-4V-3Co, Ti-8Al-1Mo-1V, and Ti-13V-11Cr-3Al. The Ti-5Al-6Sn-2Zr-1Mo-0.25Si alloy was both the least and most susceptible, depending on heat treatment. Such rankings can be drastically altered by heat-to-heat variations and processing conditions. Residual compressive stresses reduce susceptibility to stress-corrosion. Detection of substantial concentrations of hydrogen in all corroded alloys confirmed the generality of a previously proposed hydrogen embrittlement mechanism. (auth)

Preparation and Fabrication

Refer also to abstract 8222.

7870 (HEDL-TME-72-133) FFTF PRIMARY PIPING FABRICATION COMPARISON. Steichen, J. M. (Hanford Engineering Development Lab., Richland, Wash.). Oct 1972. Contract AT(45-1)-2170. 24p. Dep. NTIS.

The effects of fabrication by the Rollmet process on annealed Type 304 stainless steel piping properties have been determined. Results of the completed evaluation indicate Rollmet fabrication enhances piping properties. Rollmet fabrication enhances the tensile strength of piping material while maintaining good ductility. Stress rupture properties at 1050°F are significantly improved by Rollmet fabrication. This improvement is the result of increased ductility in the Rollmet material. The corrosion behavior of the base extrusion and Rollmet piping appears to be essentially the same. The grain size of the Rollmet piping was finer than that of the base extrusion. The finer grain size may be responsible for the improvement in mechanical properties. (auth)

7871 (RDT-E-6-34-T) FABRICATION OF CORE COMPONENT POT FOR LIQUID METAL SERVICE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 7p. RSO.

A standard prescribing requirements for fabrication of core component pots for liquid metal service for nuclear and associated applications is presented. (J.R.D.)

7872 (RDT-M-3-17-T) NICKEL–MOLYBDENUM–CHROMIUM ALLOY WELDED PIPE (ASME SA-358 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1972. 11p. Dep. RSO.

A standard prescribing requirements for nickel–molybdenum–chromium welded pipe (ASME SA-358 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

7873 THORIUM SPONGE PREPARATION BY LIQUID MAGNESIUM REDUCTION OF ThO_2. Capocchi, J. D. T. (Instituto de Pesquisas Tecnologicas, Sao Paulo, Brazil). Metalurgia (Sao Paulo); 27: No. 169, 881-90(Dec 1971). (In Portuguese).

The production of metallic thorium by direct reduction of ThO_2 with an alloy (Zn–Mg) is described. The Zn–Mg–Th ternary alloy obtained produced Th by distillation of Zn and Mg. Efficiency goes up to 15% in 20 min of reaction. (INIS)

7874 THORIUM SPONGE PREPARATION BY LIQUID ALUMINUM REDUCTION OF ThO_2. Capocchi, J. D. T. (Instituto de Pesquisas Tecnologicas, Sao Paulo, Brazil). Metalurgia (Sao Paulo); 27: No. 167, 745-9(Oct 1971). (In Portuguese).

The production of metallic thorium by pyrometallurgic reduction of ThO_2 with aluminum is described. Sequential reduction of

the obtained alloy (Al–Th) with Zn is thermodynamically easier due to the formation of an intermediate compound ($ThAl_3$). Zn is removed by distillation. (INIS)

7875 APPARATUS FOR PRODUCTION OF ZIRCONIUM METAL. Ishimatsu, Kazuhiko; Nakahara, Takao (to Nippon Mining Co., Ltd.). U. S. Patent 3,692,294. 19 Sep 1972. Filed 16 Feb 1971.

An apparatus is described for the production of zirconium metal by the reduction of zirconium tetrachloride by metallic magnesium. Magnesium chloride is formed as a by-product. (T.F.D.)

7876 SOME LESS-KNOWN FACTS ABOUT ELECTRON BEAM WELDING. Bakish, R. (Bakish Materials Corp., Englewood, N. J.). pp 3–14 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From tenth symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

Discussions are presented on efforts devoted to understanding the mechanisms of defect formation in electron beam welding. Other discussions are included on the interrelation of the beam, its focus point, and fusion zone configuration. Discussions of depth-to-width capabilities of electron beam welding are also included in which it is noted that many uses do not require large depth-to-width ratios and that costs can be reduced by selective equipment buying. It is suggested that further research is required on the large internal stresses which may exist in electron beam welds. (J.R.D.)

7877 EXPERIMENTAL USE OF A LASER TO PENETRATE URANIUM. Spitz, H. Y. Contract AT(30-1)-1156. pp 233-40 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From tenth symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

Results of calculations and research are presented which show that the rate of evaporation required for cutting bulk uranium metal using a laser beam can be achieved by increasing the power output, increasing the focal length of the lens, and using high precision lenses to focus the beam in a small area. (J.R.D.)

7878 FEASIBILITY OF PRODUCING SUPERALLOY ELECTROSLAG REMELTED HOLLOWS. Klein, H. J. (Cabot Corp., Kokomo, IN). J. Vac. Sci. Technol.; 9: No. 6, 1334-9(1972).

The feasibility of producing electroslag remelted hollows is shown. In this work electroslag hollows of two superalloys, Hastelloy alloy X and Haynes alloy No. 718 were produced. The microstructure of the as-cast hollows was significantly finer than that of a comparable ESR solid ingot. The segregation ratio defined as the maximum concentration of an element divided by the minimum concentration of the element was 1.16 and 1.33 for molybdenum for the ESR hollow and solid ingot, respectively. Mechanical property results from ring rolled and cross rolled specimens indicated that wrought properties were achieved in both alloys when total reductions exceeded 43 to 50%. An acceptable although not optimum microstructure was obtained, and the reasons for this are discussed. (auth)

7879 INFLUENCE OF ION BOMBARDMENT ON THE MICROSTRUCTURE OF THICK DEPOSITS PRODUCED BY HIGH RATE PHYSICAL VAPOR DEPOSITION PROCESSES. Bunshah, R. F. (Univ. of California, Los Angeles); Juntz, R. S. J. Vac. Sci. Technol.; 9: No. 6, 1404-5(1972).

The structure of massive deposits produced by high rate physical vapor deposition processes above 0.3 T_m substrate temperature consists of columnar grains. The length and width of the columnar grains increases with substrate temperature. Ion bombardment of the deposit during deposition by biasing the substrate negatively to 5 kV produces a marked refinement in grain size. A possible mechanism is nucleation of new grains by localized temperature spikes at the vapor-solid interface due to ion bombardment. (auth)

7880 ELECTRON BEAM FLOAT ZONE MELTING AND VACUUM DEGASSING OF NIOBIUM SINGLE CRYSTALS. Reed, R. E. (Oak Ridge National Lab., TN). J. Vac. Sci. Technol.; 9: No. 6, 1413-18(1972).

Niobium metal powder produced by electrodeposition from molten salts was electron beam float zone melted (EBFZM) for purification and growth of single crystals. It was necessary to EBFZM with a high oxygen partial pressure to reduce the carbon level. A high resistance ratio ($R_{300K}/R_{4.2K(15kG)}$= 6500) and low flow stress (τ_{1y} = 460 gm/mm^2) was obtained after a high temperature anneal (2350°C) in high vacuum (2×10^{-10} Torr). Extensive material characterization results are reported for the niobium at various stages in the purification process. The impurity content determined by chemical analyses did not correlate with the resistance ratios; however, the flow stress exhibited an excellent correlation with resistance ratio. These results imply that interstitial impurity in solid solution is the impurity distribution most affecting dislocation motion. (auth)

7881 ROTARY, LINEAR MOTION VACUUM FEEDTHROUGH. DiGiallonardo, A.; Dixon, R. D.; Anderson, K. L. (Dow Chemical Co., Golden, CO). Contract AT(29-1)-1106. J. Vac. Sci. Technol.; 9: No. 6, 1442(1972).

This paper describes a rotary, linear motion feedthrough. This was designed and built to permit film deposition from a source located below the substrate and subsequent rotation by 180° and translation of 3 in. This combination of motions was required for the film deposition and subsequent movement of the substrate and thin film into position to form one plate of a vibrating capacitor. (auth)

7882 TUNGSTEN AND MOLYBDENUM COATINGS PRODUCED BY ARC DISCHARGE IN A VACUUM. Esterlis, M. Kh. (Inst. of Electronics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 4, 28-30(1971). (In Russian).

Conditions were optimized for producing W and Mo deposits on glass surfaces from electrodes by sputtering with an arc discharge. Curves were drawn which depict the logarithmic dependence of the metal buildup rate, M, on the proximity of the electrode to the glass surface, L in cm, and which conform to the equation $M = A - B \ln L^2$, where A and B are constants. (K.S.W.)

7883 RESIDUAL STRESSES FROM GRINDING ARTICLES OF MULTI-PHASE MATERIALS. Sverdlova, B. M.; Gladkikh, L. I.; Fuks, M. Ya.; Rab, A. F. (Kharkov Polytechnic Inst.). Fiz.-Khim. Mekh. Mater.; 8: No. 4, 24-8(1972). (In Russian).

Stressed states were studied in solid alloys WC–Co, WC–Ti–Co, and a high-speed steel after polishing on a diamond wheel (concentration of diamonds was from 25 to 200%, with grain diameters from 60 to 200 μ). Special features of stress in the heterophase systems were noted, but residual stress was not macroscopic but depended instead on the identity of the phase and its properties. (K.S.W.)

Properties, Structure, and Phase Studies

Refer also to abstracts 7833, 8919, 8927, 8951, and 8952.

7884 (AD-741378) DYNAMIC PROPERTIES OF SUPERALLOYS AT ELEVATED TEMPERATURES. Final Report. Ireland, D. R. (Battelle Memorial Inst., Columbus, Ohio). Feb 1972. Contract DAAF03-71-C-0016. 119p. (AMSWE-RE-TR-71-75). NTIS.

The dynamic response properties of Cr–Mo–V, Pyromet X-15, 22-4-9, CG-27, and A286 alloys at temperatures from 72 through 1500°F were determined. Both standard Charpy and fatigue precracked specimens were used. The analyses included: characterization of the types of fracture from the appearance of the load-deflection curves; examinations of the appearance of the fracture surfaces; measurement of the various load, deflection, and energy parameters from the load-deflection record; and evaluation of the various calculated energy, strength, and toughness parameters. (auth)

7885 (AECL-4252) BUBBLE STRENGTHENING OF ZIRCONIUM ALLOYS. Schulson, E. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1972. 24p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

A theoretical analysis is presented which considers the strengthening of Zr alloys in creep through the interaction of mobile dislocations and gas bubbles. By introducing small amounts of the elements ^{9}Be, ^{6}Li or ^{10}B, He gas can be produced during neutron irradiation via the (n,α) transmutation reactions. The questions discussed in the report are: can He bubbles be produced during irradiation in a typical CANDU flux at temperatures between 300°C and 450°C; if so, what will be their expected size and number density; and what size and number density will probably be required to reduce the creep rate to $<10^{-7}$/hr. The calculations indicate that bubbles could form, but that the amount of gas likely to be produced may not be large enough to impart the desired strengthening. (auth)

7886 (BNWL-SA-4334) MATERIALS FOR LIQUID METAL FAST BREEDER REACTORS: VESSELS, PIPING, INTERNALS, AND CLADDING. Bush, S. H. (Battelle Pacific Northwest Labs., Richland, Wash.). 24 May 1972. 35p. (CONF-721104-1). Dep. NTIS.

From INCO power conference; Kyoto, Japan (28 Nov 1972).

Materials selection for liquid metal fast breeder reactor (LMFBR) primary systems including the vessel, piping, heat exchanger, steam generator, core internals, and fuel cladding is reviewed on the basis of a logic chain. Based on this approach the austenitic stainless steels appear to be the most acceptable candidates for first generation demonstration LMFBRs. However, several real or potential problems exist with these or other materials when exposed to the LMFBR environment including temperature, neutron fluence, and sodium. Specific problems discussed are creep–fatigue interactions resulting in reduced component life, sigma or chi phase embrittlement, thermal sensitization, possible stress corrosion, and void formation and swelling of core internals and fuel cladding when exposed to high neutron fluences at proposed reactor temperatures. (auth)

7887 (CEA-R-4330) STUDY OF THE EQUILIBRIUM DIAGRAM AND STRUCTURAL TRANSFORMATIONS OBTAINED BY QUENCHING AT DIFFERENT RATES OR TEMPERING OF Zr–Nb ALLOYS (0 TO 55 PERCENT Nb). van Effenterre, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1972. 91p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

The zirconium–niobium phase diagram was explored using different experimental techniques (micrography, x-ray diffractometry, resistivity, strain aging, etc.). The techniques used were of considerable help in specifying the limits of the solid solution area of Nb in α-zirconium and confirmed the existence of an immiscibility zone in this binary system. The effect of the Nb percentage on the transformation of the β phase after ice water quenching was studied. The limits of the metastable α', ω, and β'' phases were determined and the nature of the transformations discussed. It was possible to specify the sequences of the β phase transformations and their variations with temperature and quenching rate for different Nb concentration using a very fast quenching apparatus. A detailed study of the structural evolution during heat treatments for the 8% Nb alloy was performed. This study helped to identify two distinct types of ω phase formation: the first one, a diffusionless process, is marked by an invariant ω(S) temperature; the second, a process involving diffusion, leads to a metastable phase having a lower Nb concentration compared to the nominal contents of the alloy. (France)

788 (COO-1676-23) DISLOCATION-SOLUTE ATOM INTERACTIONS IN ALLOYS. Technical Progress Report. Gibala, R.; Vasudevan, A. K.; Slane, J. A.; Krupitzer, R. P. (Case-Western Reserve Univ., Cleveland, Ohio). 31 Oct 1972. Contract AT(11-1)-1676. 34p. Dep. NTIS.

Developments are reported for studies on solution hardening and softening in Nb- and Ta-base interstitial alloys; substitutional solute hardening and softening in Nb-base alloys; substitutional-interstitial solute atom interactions in Ta-base alloys; carbon-vacancy interactions in austenitic steels; and effect of texture on Snoek anelasticity. (P.C.H.)

7889 (INIS-mf-290, pp 33) ELECTRON MICROSCOPE STUDIES OF TRANSFORMATIONS IN ZIRCONIUM–CHROMIUM ALLOYS. Johanson, G. J.; Keys, L. H.; Malin, A. S. (Univ. of New South Wales, Kensington, Australia). 1972. (CONF-720217-2). INIS.

From Conference on electron microscopy; Canberra, Australia (14 Feb 1972).

The phases produced by the decomposition of the high temperature beta phase in dilute Zr–Cr alloys were examined by transmission electron microscopy. The composition of the alloys examined ranged from 0.5 to 2.5 wt% Cr and included both hypo- and hypereutectoid alloys. Observations indicated that below 1.8% Cr the beta phase transformed directly to the cph. alpha' —martensite on water quenching to room temperature. In the 0.5% alloy lath martensite was formed but this type of martensite was progressively replaced by twinned martensite as the Cr content was increased. At 1.5% Cr, the structure consisted completely of twinned martensite. At concentrations greater than 1.8% Cr the hexagonal, omega phase was also formed with the twinned alpha' —martensite. The proportion of martensite decreased with increasing Cr content until at 2.5% Cr no martensite was formed. The structure of the 2.5% alloy consisted of small sub-grains (approximately 1000Å) each of which contained an array of very fine precipitates (approximately 50Å). Electron diffraction and dark field observations indicated that each of these sub-grains was the omega phase and that the precipitates were the intermetallic $ZrCr_2$. The relationships of the observed orientations of the sub-grains were consistent with the relationships between the variants of the previously reported orientation relationship of the omega phase and the beta matrix in Ti and other Zr alloys. (INIS)

7890 (INIS-mf-290, pp 37) USE OF WEAK-BEAM IMAGES IN THE ANALYSIS OF DISLOCATION LOOPS BY TRANSMISSION ELECTRON MICROSCOPY. Kelly, P. M.; Blake, R. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). 1972. (CONF-720217-1). INIS.

From Conference on electron microscopy; Canberra, Australia (14 Feb 1972).

The established transmission electron microscope technique for analyzing dislocation loops, which are not perpendicular to their Burgers vector, depends on being able to determine the habit plane of the loops with reasonable accuracy. In the conventional micrographs used for loop identification the deviation parameter "s" is purposely kept small and the resulting dislocation loop images are broad, asymmetric, double arcs, which are appreciably displaced from the true dislocation position. These images are of limited use in obtaining the loop habit plane, particularly in cases such as irradiated Ti, where the dislocation loops are not circular, but elliptical in shape. "Weak-beam" dark field micrographs on the other hand, show narrow, symmetric loop images, which are much closer to the true dislocation position, and such micrographs can be used to determine loop habit planes with the required accuracy. In addition the "weak-beam" micrographs can be used to distinguish loops of differing Burgers vectors provided these have different values of g.b. This can be done either by examining the "weak-beam" bright field for double images or by measuring the total dislocation image shift from a pair of "weak-beam" dark fields taken with opposite "g"s. The analysis of dislocation loops in neutron irradiated Ti provides an example of the application of these techniques. Specimens were annealed for 1 hour at 510°C after irradiation. The Burgers vector of the loops was $a/2 < 1120 >$. The loops lay on planes in the vicinity of $\{41\bar{1}1\}$- i.e. the angle between the loop plane normal and the Burgers vector was about 20°. The loops were elliptical (axial ratio ~1.3) with the long axis approximately parallel to [0001]. 60% of the loops analyzed were of the vacancy type. (INIS)

7891 (UCLA-34-P-201-1) MONTE-CARLO SIMULATION OF THE OMEGA PHASE TRANSFORMATION. First Topical Progress Report for the Period January 1, 1972–December 31, 1972. de Fontaine, D.; Buck, Otto (California Univ., Los Angeles. Dept. of Materials). Jul 1972. Contract AT(04-3)-34. 33p. (UCLA-ENG-7255). Dep. NTIS.

A model of the β to ω phase transformation in Ti, Zr, and Hf alloys is proposed whereby the three-dimensional displacive transition is decomposed into one-dimensional and two-dimensional components. The one-dimensional component is postulated to be a linear displacive defect along ⟨111⟩ close-packed rows of the bcc structure, the two-dimensional component then consists of the cooperative ordering of neighboring parallel linear defects in the (111) planes normal to the linear component. That the two-dimensional cooperative ordering of displaced row segments can lead to a sharp phase transition has been demonstrated by a two-dimensional Monte-Carlo simulation involving three types of symbols with nearest-neighbor interactions. Computer simulation exhibits characteristic two-domain ω structures which, along with the linear defect structure appear to explain, at least qualitatively, observed electron and neutron diffraction patterns. It is tentatively suggested that the postulated linear defects play an important role in internal friction and in anomalous diffusion in certain bcc metals. (auth)

7892 (UCRL-Trans-10651) SIMPLIFIED METHOD FOR DETERMINING THE COEFFICIENT OF DIFFUSION OF HYDROGEN IN SOLID METALS. Dresler, Werner; Frohberg, Martin G. Translated from Z. Metallk.; 63: No. 4, 204-9(1972). 15p. Dep. NTIS.

A simplified method for the determination of the diffusion coefficient of gases through membranes, which is based on the knowledge of the behavior of the permeation current vs time curve at the point of inflexion, is described. This method was tested experimentally by applying it to the case of hydrogen diffusion through pure nickel and an iron–nickel alloy. The simplification of the evaluation process permits a significant rationalization of the test method as well as a more accurate determination of the diffusion coefficient. This latter effect is due to the fact that undesired perturbations after prolonged duration of the test may be eliminated. (auth)

7893 DENSITY AND THERMAL EXPANSION OF URANIUM ALLOYS. Makhova, V. A.; Gomozov, L. I. At. Energ. (USSR); 33: No. 5, 921-4(Nov 1972). (In Russian).

Four ternary alloy systems of U with additions of Zr, Mo, Nb,

and Ti were investigated with respect to their densities at 20°C in the γ-state and their coefficients of thermal expansion. (K.S.W.)

7894 LIFETIME OF A LONG CYLINDRICAL SHELL UNDER EXTERNAL PRESSURE AT ELEVATED TEMPERATURE. Bargmann, H. (CERN, Geneva). Nucl. Eng. Des.; 22: No. 1, 51-62 (1972).

The creep collapse of a long, thin-walled, circular, cylindrical shell subjected to external pressure was studied. The problem has been studied by Hoff et al., where elasticity has been neglected in the material equations. Here it is pointed out that elasticity must not be neglected in stability problems as it may reduce the lifetime considerably. The improved equation for the lifetime of the shell is presented. Moreover, a procedure is indicated to derive the necessary creep parameters easily from usually available creep data. Numerical values of the lifetime of thin-walled, circular, cylindrical shells under external atmospheric pressure are presented for a wide range of shells of different geometrical characteristics for a number of high-temperature alloys and the temperature range up to 1000°C. Experimental results are reported which are in good agreement with the theoretical prediction. (auth)

7895 CONTROL OF IMPURITY CONTENT IN SODIUM–POTASSIUM COOLANTS BY MEANS OF A PLUG INDICATOR. Arnol'dov, M. N.; Ivanovskii, M. N.; Pletenets, S. S.; Pleshivtsev, A. D. At. Energ. (USSR); 33: No. 5, 925-6(Nov 1972). (In Russian).

An indicator which had previously been described in a 1958 paper was employed in ascertaining the oxygen and hydrogen content of a Na–K coolant mixture. The presence of O_2 or H_2 had differing effects on the rate of plugging and the plugging temperature of the indicator. (K.S.W.)

7896 MEASUREMENT OF THE TOTAL EMITTANCE OF GRAPHITE, MOLYBDENUM, TANTALUM, AND TUNGSTEN IN THE TEMPERATURE RANGE FROM 1200 TO 2400°K. Neuer, G. (Univ., Stuttgart). Waerme Stoffuebertrag.; 4: No. 3, 133-41(1971). (In German).

A description is given of equipment for measuring the total normal emittance and the angular dependence of the emittance of solids in the temperature range from 1000 to 3000°K. The emittance is determined by comparing the radiation emitted from the surface of the sample to the radiation emitted from a blackbody. The samples are small disks and are heated in vacuum by an electron gun. The temperature measurement is by a photoelectric pyrometer in a radial hole in the sample. The measured data are recorded digitally and evaluated by means of a computer program. The error is in the region of 3%. Experimental results for graphite, molybdenum, tantalum, and tungsten are presented. (auth) (IAA)

7897 EFFECT OF HEAT TREATMENT FOR THE DISTRIBUTION OF BORON IN INCOLOY-800 ALLOY. Tanaka, M.; Kawasaki, S. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 45: No. 1, 82-6(Oct 1972).

Experiments were conducted to determine whether boron segregation occurred at grain boundaries or grain-boundary precipitates in Incoloy 800. The fission-track etching method was used along with optical microscopy. Temperature–time curves were plotted for the boron segregation, and the effect of B content on the C-shape of the curves was studied. Activation energies for boron segregation are different from those for carbide segregation. The rate of carbide precipitation is influenced by the B content in the matrix. (D.L.C.)

7898 PHASE TRANSITION OF AMERICIUM METAL. Sari, C.; Mueller, W.; Benedict, U. (Technische Univ., Karlsruhe, Ger.). J. Nucl. Mater.; 45: No. 1, 73-5(Oct 1972).

The question of whether a phase transition in Am occurs between 600 and 700°C was studied. By high-temperature metallography, no phase transitions were observed up to 700°C. Cycling 20 times between 200 and 700°C at a rate of 1000°C/h did not result in structure damage. Quenching from 200 to 1000°C to room temperature did not produce recrystallization or changes in grain size or shape. The high-temperature solid–solid transition at 1074°C and melting at 1175°C were observed. After quenching to room temperature, a dhcp structure with $a = 3.473 \pm 0.009$ Å and $c = 11.232$ Å was observed. (D.L.C.)

7899 ANNEALING OF A COLD-ROLLED Pu–1 WT. PERCENT Ga ALLOY. Beitscher, S. (Dow Chemical Co., Golden, CO). Contract AT(29-1)-1106. J. Nucl. Mater.; 45: No. 1, 1-9(Oct 1972).

The variation of the yield strength, strain hardening, and ductility during annealing of cold-rolled Pu–1 wt % Ga alloy was determined by means of tensile tests at room temperature. Specimens rolled 20, 40, 65, and 80% were annealed at temperatures between 200 and 300°C for times up to 1000 min. It was found that there was a linear relation between the strain hardening exponent and the fractional decrease in yield strength, and that the relation was independent of the prior deformation in the specimens or temperature of annealing. As a result, the variation of the ultimate strength with the yield strength differed for different amounts of prior cold work. Fracture elongations varied approximately linearly with the yield strength in a manner independent of prior deformation or annealing temperature. The final softening fraction by recovery determined from the yield strength of 20% rolled specimens varied from 0.1 at 200°C to 0.5 at 300°C. The final softening fraction by recovery did not vary with the amount of prior cold work in specimens annealed at 200°C. (auth)

7900 LINDEMANN MELTING CRITERION AND THE CHARACTERISTIC TEMPERATURE FOR CUBIC CRYSTALS. Oshcherin, B. N. (Leningrad Technological Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 73-8(1972). (In Russian).

The melting criteria of Lindemann for cubic crystals of simple substances and binary inorganic compounds were examined. The energy required to overcome potential barriers during diffusion was used to confirm the differences observed in Lindemann values. Tabulations for the Lindemann and activation energies of self-diffusion are given for crystals of inert gases, molecular crystals (CH_4, NH_3, etc.), and a number of metals including Ag, Au, Cu, Pt, Al, β–Ti, β–Zr, β–Hg, V, Nb, Ta, Th, β–La, γ–Ce, and the inorganic compounds UC, ThC, $MoC_{0.66}$, ThO_2, and UO_2. (K.S.W.)

7901 STUDY OF ELECTRODEPOSITED ALLOYS. PART II. THE HARDNESS AND WEAR-RESISTANCE OF ELECTRODEPOSITED Cr–Mo ALLOY. Kaoru, Aotani; Kazuo, Nishimoto. Kinzoku Hyomen Gijutsu; 21: No. 7, 356-62(1970). (In Japanese).

Electrodeposited Cr-Mo alloys were obtained from a Cr bath containing a molybdenum salt, using normal conditions for deposition of Cr coatings. The Cr-Mo coatings contained more than 3% Mo, were approximately 50 μ in thickness, and had a Vickers hardness of 1000 to 1300, which is higher than that of normal Cr coatings, while the wear resistance of the Cr-Mo coatings was 2 to 3 times greater than that of normal Cr coatings. Hardness was increased by 100 units, and wear reduced by 4 mg on addition of 1% Mo to coatings. (Referativnyi Zh.)

7902 ROLE OF IMPURE ATMOSPHERES IN THE BRITTLE FRACTURE OF POLYCRYSTALLINE MOLYBDENUM AT ROOM TEMPERATURE. Verner, V. D.; Kiseleva, V. N; Piguzov, Yu. V.; (and others). Fiz. Metal. Metalloved.; 33: No. 6, 1320-2(Jun 1972). (In Russian).

Mo strips 1 mm wide and 0.35 mm thick were used in measurements of internal friction after specified mechanical and thermal treatments in an argon bath. The effects of temperature on the height of the Snoek peak (Snoek, 1941) were observed. Strips of Mo which had been subjected to similar treatment but in atmospheres containing O_2, N_2, or C-containing compounds were also tested. The data showed that the conversion of Mo at room temperature from a ductile state to a brittle state after high-temperature exposure to atmospheres containing impurities was the result of the separation of carbides on the grain boundaries of the sample. (K.S.W.)

7903 EFFECT OF ALLOYING ELEMENTS ON THE ORDERING IN THE SYSTEM NICKEL–MOLYBDENUM. Kirienko, V. I.; Poplavskaya, E. E.; Potapov, L. P. (Inst. of Metal Science and Physics of Metals, Moscow). Fiz. Metal. Metalloved.; 33: No. 6, 1260-6(Jun 1972). (In Russian).

Electron microscope and x-ray studies were made on the effects of small additions of V and Nb on the isothermal conversions in Ni alloys with about 19% Mo in the temperature range 700 to 800°C. A significant hindering effect by V additions on the isothermal conversions was observed, particularly at 800°C. Alloying with V and Nb broadened the ($\alpha + Ni_3Mo$) region of the phase composition diagram in the lower temperature ranges, altering the Ni_4Mo conversion temperature. The possible mechanism in retarding the conversion processes is discussed. (tr-auth)

7904 PHASE TRANSFORMATIONS DURING BREAKDOWN OF SOLID SOLUTIONS IN ALLOYS OF Cu–1 PERCENT Be–4 PERCENT Ag AND Cu–0.5 PERCENT Be–1.3 PERCENT Ti. Zakharova, M. I.; Kao-Min-Ti; Moshkov, V. V. (Moscow State Univ.). Fiz. Metal. Metalloved.; 33: No. 6, 1243-8(Jun 1972). (In Russian).

Phase conversions in alloys of Cu–1% Be–4% Ag and Cu–0.5% Be–1.3% Ti during the decomposition of solid solutions were investigated by x-ray and electron microscope techniques. The

breakdown of supersaturated solutions at 218 and 300°C occurred by means of the separation initially of the metastable coherent phases β'-Cu_3Ti and γ'-CuBe, and thereupon the equilibrium phases β-Cu_3Ti and γ-CuBe. Crystals of the metastable phase separated with a ⟨100⟩ orientation, forming a periodic structure. (tr-auth)

7905 STUDY OF STRUCTURE TRANSFORMATIONS IN Zr–Nb ALLOYS. II. Guerillon, J. P. Metaux (Corros.-Ind.); 47: No. 557, 21-40(Jan 1972). (In French).

During the direct hardening of alloys containing less than 8% Nb, the β solid solution transforms partially or totally into an α' phase solution, supersaturated with Nb. The variation of its parameters (in angstroms) as a function of the Nb contents, x (expressed as at. %) was established to have the following form: $3.231-0.00375x$. The variation of the a_β parameter (in angstroms) of the β solid solution was also established as a function of Nb contents, x (expressed as at. %). The variation in the Vickers hardness of two series of hardened and annealed alloys was established as a function of the Nb contents, three different cases being distinguished: dilute alloys, alloys containing between 5 and 13% Nb, and alloys containing in excess of 15% Nb. The effect of oxygen on the position of the solvus line $(\alpha + \beta(Zr)/\beta(Zr))$ after annealing at 750°C was studied. During the quench-hardening of alloys containing more than 7%, the α' phase is no longer formed, the β solid solution partially decomposing and giving rise to a quench-hardened ω phase or an x phase. The quench-hardened ω phase has a hexagonal structure derived from the bcc structure of the β matrix. The x phase of the hexagonal structure appears during the decomposition, by quench-hardening, of β solutions containing more than 13% Nb. Both the ω and x phase have the same Widmanstaetten-type platelet precipitates. During tempering at 400°C, the quench-hardened ω phase and the x phase lead to the tempered ω phase of trigonal structure. (France)

7906 ABNORMAL SPOTS IN ELECTRON DIFFRACTION PATTERNS OF THE G–P ZONES OF Cu–Be AND Ni–Be ALLOYS. Kainuma, Toshio (National Research Inst. for Metals, Tokyo); Watanabe, Ryoji; Iizuka, Masahiro. Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku; 14: No. 4, 203-10(Nov 1971). (In Japanese).

Studies were made on the initial process of aging of Cu–1.8 wt % Be and Ni–2.5 wt % Be alloys by the use of an electron microscope of transmission type and by electron diffraction. Guinier–Preston (G.P.) zones of both alloys were formed in the initial stage of aging below 300 and 600°C, respectively. The electron diffraction behavior of the alloys resembled each other quite well. Long streaks appeared in ⟨100⟩ direction due to formation of the platelike G.P. zones. Abnormal spots appeared at the points corresponding to inhibited reflection points. The appearance of the spots and the long streaks was simultaneous. The abnormal spots were noticed in diffraction patterns of (100), (211), (111), and (310) planes but not in the pattern of (110) plane. These abnormal spots were attributable to crossing of the long streaks in the ⟨100⟩ direction and reflection sphere. By this assumption, it is possible to explain all the abnormal spots, which appeared in the diffraction patterns of the planes mentioned above. The aging was made up to 1568 hours. (Japan)

7907 ANALYSIS OF THERMALLY-INDUCED PLANE WAVES IN ELASTIC–PLASTIC SINGLE CRYSTALS. Johnson, J. N. (Sandia Labs., Albuquerque, NM). J. Mech. Phys. Solids; 20: No. 6, 367-80(Dec 1972).

An analytical framework for the calculation of thermally induced plane waves in elastic-plastic single crystals of arbitrary crystallographic symmetry and orientation is presented. Plasticity is described in terms of small strain theory and the available slip-planes which can be arbitrary in number as well as in orientation. The effects of perfect-plasticity modify not only the anisotropic elastic moduli, but also the components of the Grüneisen tensor. The latter effect is a consequence of a nonspherical stress state developed in anisotropic materials during rapid energy-absorption at constant strain. Specific examples of thermally-induced plane waves are presented for both the elastic and plastic response of beryllium and graphite single crystals. (auth)

7908 ANODIC DISSOLUTION OF InSb IN MIXED HALIDE–SULFATE SOLUTIONS (STEADY-STATE METHOD). Mikhailova, V. P.; Malev, V. V.; Durdin, Ya. V. J. Appl. Chem. USSR (Engl. Transl.); 45: No. 5, 1025-8(May 1972).

Translated from Zh. Prikl. Khim.; 45: No. 5, 996-1000(May 1972).

Studies were made on the anodic dissolution of indium antimonide single crystals in HCl and H_2SO_4 + KCl (KBr) solutions in order to provide additional information on the mechanism of the process. The results showed that the semiconductor nature of InSb had virtually no effect on the character of anodic dissolution either of the indium or of the antimony surface. Since the surface remained qualitatively unchanged during dissolution even in the presence of adsorption, in the case of formation of surface compounds the determining step is probably their transfer into solution. (P.C.H.)

7909 FIELD ION MICROSCOPE STUDY OF ADSORPTION SOFTENING OF NEEDLE MICROCRYSTALS. Mikhailovskii, I. M.; Dranova, Zh. I.; Afanas'ev, V. I. (Kharkov Pedagogical Inst.). Fiz. Metal. Metalloved.; 34: No. 1, 71-5(Jul 1972). (In Russian).

The softening of tungsten microcrystals under the influence of low-temperature (78°K) adsorption of the surface-active components of a residual gas was studied under near-vacuum conditions (5×10^{-6} torr). This effect reached a maximum at a sample diameter of ~700 Å. With further decreased diameter of the crystals, the softening effect was reduced, and reached roughly zero at a diameter of ~300 Å. The surface-active component of the residual gas also promoted a lowering of the resistance of the microcrystals to plastic deformation. (tr-auth)

7910 VARIATION OF ANISOTROPY OF PLASTIC DEFORMATION OF BERYLLIUM SINGLE CRYSTALS AFTER PROGRAMMED LOADING. Gindin, I. A.; Laptev, I. N.; Neklyudov, I. M.; Tikhinskii, G. F. Fiz. Metal. Metalloved.; 34: No. 1, 160-5(Jul 1972). (In Russian).

The effects of a previously programmed loading on the critical stress of the commencement of twinning and slipping were studied in Be single crystals of different orientations. Prolonged annealing under evenly increasing loading to 25% increased the stress tendency along basic planes, and noticeably lowered the cleavage stress along other planes. Such non-additive action of programmed loading on shear stress in various planes was the result of oriented redistribution of impurities in the body of the crystal. (tr-auth)

7911 INFLUENCE OF MECHANICAL TWINNING ON THE TEXTURE OF ROLLED INDIUM. Tokarev, B. Ya.; Khayutin, S. G. Fiz. Metal. Metalloved.; 34: No. 1, 149-54(Jul 1972). (In Russian).

The influence of the original orientation of In microcrystals on the texture of the polycrystal formed during hot deformation was investigated. The deformation by twinning played an important role in the resulting texture, and the intensity of deformation twinning was determined by the original orientation. The presence of twins imposed a severe limitation on the number of preferred orientations. (K.S.W.)

7912 RECRYSTALLIZATION OF DYSPROSIUM. Pavlov, V. S.; Mashkarova, V. T.; Ivantsov, I. I.; Belovol, V. S. (Physical-Technical Inst., Kharkov). Fiz. Metal. Metalloved.; 34: No. 1, 143-8(Jul 1972). (In Russian).

The recrystallization of two types of Dy was studied by metallographic and x-ray techniques. A technical grade (99.4%) of Dy was examined at 475 to 1,100°C; a vacuum-distilled sample of Dy (99.97%) at 475 to 750°C. The recrystallization of both samples occurred at the same temperature. Grain growth was noticeable in distilled Dy, but not in the technical Dy. The activation energy of grain growth in distilled Dy was −25 kcal/mole. (tr-auth)

7913 REACTIONS OF ZIRCONIUM AND SILICON IN THE PRESENCE OF EXCESS CARBON. Rakcheeva, V. I.; Mashkovich, L. A.; Perkova, G. A.; (and others). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 5, 385-8(May 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 5, 57-61(May 1972).

Chemical transformations occurring during thermomechanical treatments (1200 to 2800°C in hot press) of carbon materials (coke and coal pitch) containing 2.5% Si and/or 7.5% Zr were studied by chemical phase analysis. Results indicate that free Si and combined ZrO_2 are present only up to 1600°C, while small amounts of free Zr remained up to 2200°C. Raising the temperature increased the SiC and ZrC fractions. X-ray diffraction studies confirmed the above trends and showed a change from β- to α-SiC at 2000°C. X-ray structural analysis showed that the alloying additions increase the ordering of the graphite lattice and that the structural changes are related to the carbide formation process. (D.L.C.)

7914 STRUCTURAL CHANGES DURING ANNEALING OF DISPERSION-HARDENED TUNGSTEN ALLOYS. Vedernikova, V. A.; Mil'man, Yu. V.; Postnov, L. M.; (and others) (Inst. of Metal Physics, Kiev). Metallofizika; No. 40, 45-9(1972). (In Russian).

Structural changes in deformed W containing 0.2% ZrC were studied during its annealing by means of the transmission electron microscope, by metallography, and through a measurement of the width of diffraction lines. The dispersed cellular

structure which was stabilized by the separation of the second phase (ZrC) was preserved up to 1,800°C, and in some portions of the alloy, up to 2,340°C. An increase in the temperature of recrystallization was accompanied by an increase in heat stability. (tr-auth)

7915 DIFFUSIVE BORATING OF MOLYBDENUM AND NIOBIUM IN BORON CARBIDE POWDER. Sosnovskii, L. A.; Epik, A. P.; Kraplya, A. P. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 75-8(Sep 1972). (In Russian).

The effect of different activators on the process of molybdenum and niobium borating in boron carbide powders was investigated. Kinetics of the borating was studied. Salts of fluoroboric acid were found to be the best activators. (auth)

7916 LATTICE DYNAMICS AND THE HEAT CAPACITY OF INDIUM. Kumar, Ashok; Sharan, B. (Indian Inst. of Tech., New Delhi). J. Phys., C (London); 5: No. 22, 3161-3(14 Nov 1972).

The frequency distribution spectrum and the heat capacity of indium have been recalculated, correcting the work of Slutsky and Livingston (J. Chem. Phys.; 32: 1093-6(1960)). In the $\theta_D - T$ curve, so obtained, the agreement is found to be satisfactory between 5 and 100°K. An abnormality is observed in the T_2 branch of the dispersion curve in the [100] direction. (auth)

7917 INTERACTION OF THE LAVES PHASES IN THE SYSTEMS $Zr[Fe, Co, Ni]_2$–$Hf[Fe, Co, Ni]_2$. Svechnikov, V. N.; Markiv, V. Ya.; Pet'kov, V. V. (Inst. of Metal Physics, Kiev). Metallofizika; No. 40, 95-7(1972). (In Russian).

Interaction of the Laves phases was studied in the two systems Zr {Fe, Co, Ni} and Hf {Fe, Co, Ni} by differential thermal, x-ray and microstructural analyses. The system $ZrFe_2$–$HfFe_2$ is quasi-binary and peretectic, and characterized by a significant solubility of Hf in the metallide $ZrFe_2$ (about 21 at.% at 1,500°C and about 18 at.% at 900°C). The solubility of Zr in $HfFe_2$ is insignificant. The compounds $ZrCo_2$ and $HfCo_2$ formed a continuous series of solid solutions. In the system Zr–Hf–Ni a Laves phase was not detected at the 66.7 at.% Ni section. (tr-auth)

7918 HOLD-TIME EFFECTS ON THE ELEVATED TEMPERATURE FATIGUE-CRACK PROPAGATION OF TYPE 304 STAINLESS STEEL. James, L. A. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 16: No. 3, 521-30(Dec 1972).

Fracture mechanics techniques were used to study the effects of loading waveform and hold-time on the fatigue-crack propagation behavior of Type 304 stainless steel at 1000°F. At frequencies of 4 cpm and 0.33 cpm, there was little observable difference between the results using a sawtooth waveform, and those using a square wave with hold-time. However, at 0.083 cpm, the tests with hold-times exhibited a somewhat lower rate of crack growth than those using a sawtooth waveform. The reason for this is unknown, but several possible explanations are offered. (auth)

7919 CHARACTERIZATION OF THE FRACTURE TOUGHNESS OF ZIRCALOY. Walker, T. J. (Bettis Atomic Power Lab., West Mifflin, PA). Nucl. Technol.; 16: No. 3, 509-20 (Dec 1972).

The utilization of Zircaloy for pressurized-water, nuclear-power reactor core structure and cladding applications results in numerous design examples with either sharp edge defects or joints which approximate sharp cracks. For the characterization of fracture toughness, specimens were machined from an ingot of Zircaloy-4 which had been hot rolled to a 1 inch thickness and retained in the mill annealed condition (i.e., hot rolled at 1550°F, reheated to 1550°F for 15 minutes after rolling and air cooled). The basal pole fractions were $f_L = 0.073$, $f_T = 0.415$ and $f_N = 0.512$. The testing for fracture characterization was conducted with 1X WOL (wedge opening loading) and 0.4X CT (compact tensile) specimens. Orientation effects introduced by the preferential alignment of the basal planes during rolling have been determined by the sub-sized CT specimens. Also the fracture surfaces were studied with a scanning electron microscope and evidence of large local ductility was observed for all specimens including those fractured at −150°F. Small, hollow, conical projections from the fracture surface are superimposed on larger similarly shaped projections. A model for fracture consistent with the SEN views is the formation of small isolated spheroidal holes, less than 10% of grain size, then growth and coalescence of the holes to form the larger conical projections of grain size or larger. (auth)

Radiation Effects

Refer also to abstracts 8916 and 8917.

7920 (ANCR–1063) DAMAGE IN HIGHLY IRRADIATED 1100 ALUMINUM. Beeston, J. M.; Korth, G. E.; Martin, M. R.; Brinkman, C. R. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jun 1972. Contract AT(10-1)-1375. 32p. Dep. NTIS.

Aluminum components in the ATR receive high irradiation fluences in relatively short times, so that material with high fluence is of interest in the evaluation of service life of reactor components. An 1100 aluminum skirt plate which had been removed from the MTR after 18 years accumulation at 70°C of a peak fast fluence of 5.6×10^{22} n/cm^2 E > 1 MeV and thermal fluence of 6.5×10^{22} n/cm^2 was cut into specimens; these were tested to define the growth, mechanical properties, and compositional and structural changes. The aluminum had retained sufficient ductility so that it was still serviceable. The tests and the changes observed are reported. (auth)

7921 (HEDL–72-121) IRRADIATION TEMPERATURE DEPENDENCE OF VOID FORMATION IN COLD WORKED TYPE 316 STAINLESS STEEL. Brager, H. R.; Straalsund, J. L. (Hanford Engineering Development Lab., Richland, Wash.). Oct 1972. Contract AT(45-1)-2170. 10p. Dep. NTIS.

The irradiation temperature dependence of void formation in cold-worked Type 316 stainless steel is different from that of the solution-treated steel. The difference appears to be due to the thermal stability, or recovery kinetics, of the cold-worked microstructure. The temperature dependence is similar to, but more subtle than, that previously reported for cold-worked Type 304 stainless steel. (auth)

7922 (HEDL-TME–72-132) EFFECT OF TEMPERATURE AND NEUTRON IRRADIATION UPON THE FATIGUE-CRACK PROPAGATION BEHAVIOR OF ASTM A533 GRADE B, CLASS 1 STEEL. Heavy Section Steel Technology Program Technical Report No. 21. James, L. A.; Williams, J. A. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1972. Contract AT(45-1)-2170. 29p. Dep. NTIS.

The fatigue-crack propagation behavior of ASTM A533 Grade B, Class 1 steel was studied within the framework of linear-elastic fracture mechanics. Tests were conducted at 75°F (24°C) and 550°F (288°C) on unirradiated material, and on material irradiated at 550°F to 2.3 to 2.8×10^{19} n/cm^2 and 5.3 to 5.7×10^{19} n/cm^2 (E > 1 MeV). In general, at the cyclic frequency used (600 cpM), neither temperature nor neutron irradiation had a significant effect on the fatigue-crack propagation. (auth)

7923 (INIS-mf-288, pp 51-51a) STRUCTURAL AND ELECTRICAL CHARACTERISTICS OF IRRADIATED OXIDE FILMS ON ZIRCONIUM ALLOYS. Shirvington, P. J.; Barton, S. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). 1972. (CONF-720218-1). INIS.

From 3rd Australian conference on electrochemistry; Terrigal, Australia (15 Feb 1972).

Some proposed mechanisms of radiation enhancement of zirconium oxidation are discussed in the light of recent results pertaining to the structure and electrical properties of ZrO_2 films formed under conditions of oxidation enhancement. Enhancement of oxidation may result from either: (1) the occurrence of holes in the oxide film which allow direct access of molecular oxidant (H_2O or O_2) to the metal, or (2) the formation of an oxide crystal structure possessing high concentrations of ionic defects through which oxygen ions and electrons (or holes) may pass with ease. The occurrence of these phenomena may be deduced from the electrical characteristics of the oxide film provided the measurements are taken at >270°C and provided the outer contact to the oxide is both a liquid and a source of oxygen at this temperature. A molten nitrate/nitrate eutectic meets these requirements. By combining the results of laboratory electrical measurements on specimens pre-oxidized in pressurized water in a neutron flux with electron microscope observations it has been possible to show that the transport of molecular oxidant down micro-fissures in the oxide film is the chief factor involved in oxidation enhancement of most Zr alloys. The Zr–2.5 wt % Nb alloy exhibits a radiation suppression of oxidation although the out-of-flux oxidation rate is enhanced by molecular oxygen. This apparent anomaly can be attributed to an oxide structure possessing few micro-fissures but ionically defective due to doping by Nb^{5+}. (INIS)

7924 (RFP-Trans–119) ROLE OF STATISTICAL FLUCTUATIONS IN TEXTURE DURING THE RADIATION GROWTH OF URANIUM. Novak, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated for Dow Chemical Co., Rocky Flats Div., from report UJV–2795-M. 7p. Dep. NTIS.

Influences of the statistical fluctuations on the preferred orientation of uranium grains in the fuel element distortion under irradiation have been examined. It has been supposed for simplicity that uranium grains grow under irradiation in direction b and

contract isotropically in perpendicular directions. Models yield a value of mean square of the angle between directions of the axis of the distorted cylindrical specimen determined at both basal planes of the cylinder as a function of the radiation growth of individual grains, of the grain size and of the geometry of the cylindrical specimen. Numerical values obtained using models were in accordance with the result of an irradiation experiment. (auth)

7925 RECOVERY OF ELECTRON-IRRADIATED PLATINUM. Pt. 3. STAGE 2 ANNEALING. Schilling, W.; Sonnenberg, K.; Dibbert, H. J. (Kernforschungsanlage, Juelich, Ger.). Radiat. Eff.; 16: No. 1-2, 57-64(Sep 1972).

Recovery data in the temperature range of stage II are presented for nominally pure Pt samples and dilute Pt–Au alloys. The dilute alloys exhibit three well-defined substages near 28, 42, and 90°K. Evidence is presented which points toward a rearrangement of trapped interstitials at Au-atoms in the substages at 28 and 42°K and to dissociation of interstitials from Au-atoms at 90°K. At low initial defect densities the nominally pure samples exhibit substages near 120°K and in the temperature range between 200 and 500°K. Probably most of these substages are not of intrinsic character but are related to residual impurities. At high initial defect densities a gradual and continuous intrinsic stage II recovery was observed. (auth)

7926 EFFECTS OF INJECTED HELIUM ON VOID FORMATION IN PROTON-IRRADIATED TYPE 316 STAINLESS STEEL. Keefer, D. W.; Pard, A. G. (Atomics International, Canoga Park, CA). Contract AT(04-3)-824. J. Nucl. Mater.; 45: No. 1, 55-9(Oct 1972).

Samples of 316 stainless steel were injected with He at room temperature and proton irradiated at 500°C (at constant displacements and rates). It was found that a 100x increase in He leads to a 5x increase in void density with a concurrent decrease in void size. In an attempt to simulate the reactor condition, a sample was subjected to three incremental helium injection–proton irradiation cycles, using shields over portions of the sample. Results indicate that the initial irradiation damage inhibited void nucleation during the second irradiation, but in the third cycle, the void density, void size, and swelling all increased. The transformation of austenite to ferrite occurred in the third cycle, but after the voids were established. (D.L.C.)

7927 COMPARISON OF THE THEORETICAL AND ACTUAL RATES OF CREEP IN A FAST REACTOR. Gittus, J. H. (United Kingdom Atomic Energy Authority, Preston, Eng.). J. Nucl. Mater.; 45: No. 2, 174(Nov 1972).

The equation for the creep rate, $\dot{\epsilon} = z\sqrt{2}\ (S/a\sqrt{\rho})(\sigma/G)$, was compared with experimental data for irradiated stainless steel. Agreement is good for stresses of 10,000 and 20,000 psi. (D.L.C.)

7928 NATURE AND THERMAL STABILITY OF RADIATION-INDUCED DEFECTS IN SINGLE-CRYSTAL TUNGSTEN. Bykov, V. N.; Birzhevoi, G. A.; Zakharova, M. I.; Solov'ev, V. A. At. Energ. (USSR); 33: No. 4, 809-13(Oct 1972). (In Russian).

Based on measurements of electric resistance, a study of defects in single-crystal tungsten after irradiation at 450 to 500°C by a neutron flux of 1.4×10^{22} n/cm^2 (4×10^{21} n/cm^2 for E > 1 MeV) has been conducted. Three stages of annealing of radioinduced defects have been found in the temperature ranges 500 to 800, 950 to 1200, and 1200 to 1900°C, the maxima of recovery rates of which lie at 0.24, 0.35 and 0.45 T_m, respectively, where T_m is the melting temperature of tungsten in °K. The activation energies of the stages are 0.70 ± 0.03 eV for 0.24 T_m (stage IV), 3.2 ± 0.3 eV for 0.35 T_m (stage V) and 6.4 ± 0.5 eV for 0.45 T_m (stage VI). A 0.2% accumulation of rhenium in the tungsten samples takes place as a result of (n,γ) reactions during irradiation under the above conditions. (auth)

7929 BINDING BETWEEN POSITRON AND DISLOCATION IN ALUMINIUM. Hautojaervi, P. (Univ. of Helsinki). Solid State Commun.; 11: No. 8, 1049-52(15 Oct 1972).

The interaction of positrons and dislocations has been studied in aluminum by analyzing the effect of deformation on the angular correlation of the 2 γ-annihilation radiation. The binding energy of trapped positrons is estimated by a rough model to be 0.57 ± 0.10 eV. The average decrease in valence electron density seen by positrons at dislocations is 16%. These figures are an order of magnitude larger than one expects on the basis of the electric properties of dislocations predicted by the isotropic theory of elasticity. (auth)

7930 RADIATION EFFECTS DURING NEUTRON IRRADIATION OF STRONGLY DEFORMED COPPER. Gindin, I. A.; Matsevityi, V. M.; Starodubov, Ya. D.; Lapiashvili, E. S. Fiz. Metal. Metalloved.; 34: No. 1, 223-4(Jul 1972). (In Russian).

Studies were made on the effects of fast-neutron irradiation on the temperature stability of mechanical properties of polycrystalline oxygen-free copper (99.98%) which had been rolled to 50% at 77°K. Within limits, the time-temperature regime of annealing had little effect on the mechanical properties of unirradiated, rolled samples. Irradiation of rolled Cu resulted in softening. (K.S.W.)

7931 SINTERED STEEL X13 FOR REACTOR FUEL ELEMENT CLADDING FOR FAST NEUTRON REACTORS. II. STEEL CONTAINING TiO_2. Denisenko, E. T.; Van Asbruk, F. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 95-101(Sep 1972). (In Russian).

Four steel compositions with about 11% Cr, and up to 2% Mo, 1% W, and 2% TiO_2, were prepared as sintered ferrite steels and "soaked" at 725°C for 2200 h prior to structure studies, strength comparisons, and creep tests. The presence of TiO_2 enhanced the creep stability of the ferrite steels at 700°C. These properties are discussed in terms of the usefulness of these types of sintered steels when subjected to long-term reactor radiation. (K.S.W.)

7932 POSTIRRADIATION MECHANICAL PROPERTIES OF TYPES 304 AND 304 + 0.15 PERCENT TITANIUM STAINLESS STEEL. Bloom, E. E.; Stiegler, J. O. (Oak Ridge National Lab., TN). Nucl. Technol.; 17: No. 1, 24-37(Jan 1973).

The tensile and creep-rupture properties of types 304 and 304 + 0.15% Ti stainless steels have been determined after irradiation at temperatures in the range 400 to 820°C to maximum neutron fluences of 3.5×10^{22} neutrons/cm^2 (>0.1 MeV). Changes in mechanical properties were related to the microscopic observations of irradiation-produced defects. When irradiated in the annealed condition in the neighborhood of 450°C, type 304 stainless steel exhibited an increased yield stress, reduced strain hardening coefficient, and reduced uniform and total elongation. The increased yield stress could be correlated with the strengthening expected from irradiation-produced voids and dislocations. With increasing irradiation temperature the concentration of these defects decreased and thus the magnitude of the yield stress increase became less. At 500 to about 600°C irradiation and test temperature a pronounced reduction in creep-rupture ductility was observed. Fractures were intergranular. It is suggested that in this temperature range the void-dislocation structure together with the transmutation-produced helium were responsible for the intergranular fractures and low ductilities. At higher temperatures no void-dislocation structures were formed. For these conditions the ductilities were higher than in the 500 to 600°C range but still significantly below the unirradiated value. Variation in alloy composition and preirradiation microstructure had a strong influence on the postirradiation properties. Type 304 + 0.15% Ti stainless steel exhibited significantly higher tensile and creep-rupture ductilities than the standard alloy when irradiated and tested above 450°C. The strength properties of specimens irradiated in the 10% cold-worked condition were similar to those of material irradiated in the annealed condition, but the total elongation and reduction in area were slightly lower. (auth)

Other Materials

Refer also to abstracts 7907, 7913, 7945, and 8898.

7933 (ORNL–4503(Vol.5)) THORIUM CERAMICS DATA MANUAL. VOLUME V. SULFIDES. Peterson, Sigfred (Oak Ridge National Lab., Tenn.). 1972. Contract W-7405-eng-26. 12p. Dep. NTIS.

Physical, chemical, and mechanical properties of thorium sulfides, alone and in combination with other sulfides and other thorium compounds, are compiled from the literature through November 1971. Although the phase equilibria in the thorium–sulfur system are not well known, the compounds ThS, Th_2S_3, Th_7S_{12}, ThS_2, and ThOS are reasonably well characterized chemically and physically. Mechanical property data are sparse, and very little is known about systems with other compounds except for ThS–US. (30 references). (auth)

7934 SOLID WASTE–PLASTICS COMPOSITES: PHYSICAL PROPERTIES AND FEASIBILITY FOR PRODUCTION. Fan, L. T.; Retzloff, D. G.; Vanderpool, W. O. (Kansas State Univ., Manhattan). Environ. Sci. Technol.; 6: No. 13, 1085-91(Dec 1972).

The feasibility of producing a composite by radioinduced polymerization using solid waste and methyl methacrylate as starting materials was investigated. Composites were prepared from the following solid wastes: used computer printout paper containing green dye and ink printing, newsprint, sawdust from fir lumber, cardboard, bagasse, wheat straw, dried sediment from the pri-

mary treatment of municipal sewage, sludge from secondary sewage treatment, cotton cloth, clothes lint, and human hair. These preliminary composites machined easily and their water absorption rates were inversely related to their polymer contents. The compression and tensile strengths as well as Rockwell hardness of the waste paper composites were found to be comparable or superior to those of standard construction materials such as concrete, aluminum, and wood. Samples prepared under anerobic conditions exhibited greater tensile and compression strength than those prepared under ambient conditions. The Rockwell hardness values of the samples were insensitive to the presence of oxygen during preparation. From their observed physical properties it was concluded that such composites are suitable for use as wood substitute materials. (auth)

7935 RECENT DEVELOPMENTS OF COATINGS FOR GCFR AND HTGCR FUEL PARTICLES AND THEIR PERFORMANCE. Ford, L. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.); Hibbert, N. S.; Martin, D. G. J. Nucl. Mater.; 45: No. 2, 139-49(Nov 1972).

Recent developments in the fabrication and properties of pyrolytic carbon and silicon carbide coatings, suitable for coated nuclear fuel particles, are described. Particularly, these properties are related to the performance of fuel particles suitable for high-temperature gas-cooled reactors and on a rather more tentative basis for gas-cooled fast reactors. Silicon carbide coatings can withstand appreciable tensile stresses, particularly if the flaw size in the coating surface is minimised. This feature of silicon carbide, in addition to its dimensional stability under fast neutron dose, allows a change in the philosophy of coated particle design, in turn leading to increases in performance. Methods of preparing pure dense silicon carbide in the temperature range 1200 to 1700°C are described, together with dense isotropic pyrolytic carbons which can be deposited from butane, propylene, or acetylene. The effects of these advances on coated particle design are also discussed. (auth)

7936 EROSION OF GRAPHITE SURFACE EXPOSED TO HIGH-TEMPERATURE SUPERSONIC HYDROGEN GAS. Sharma, O. P. (Princeton Univ., NJ). J. Spacecraft Rockets; 9: No. 11, 785-6(Nov 1972).

Recently, an experimental study was conducted to obtain erosion rates of a graphite composite (AGCarb-101) in high-temperature supersonic stream of H gas. A theoretical model based on laminar boundary-layer flow equations was developed to predict these erosion rates. Satisfactory agreement was obtained between computation and experimental data. (D.L.C.)

7937 MODIFICATION OF SELF-EXTINGUISHING POLYETHYLENE COMPOSITIONS FOLLOWING IRRADIATION. Braginskii; R. P.; Parfenova, D. S.; Troitskii, I. D.; Finkel, Eh. Eh.; Chervontseva, G. M. Plast. Massy.; No. 1, 15-18(Jan 1972). (In Russian).

The radioinduced modification of self-extinguishing polyethylene compositions used in cable fabrication was investigated. The possibility and expediency of such modification in low-density polyethylene for the purpose of enhancing its heat stability and improving its physicomechanical characteristics at elevated temperatures were considered. (tr-auth)

7938 DIFFUSION AND SOLUBILITY OF GASES IN TEFLON FOLLOWING IRRADIATION. Savin, A. G.; Vaisberg, S. Eh.; Karpov, V. L. Plast. Massy; No. 2, 3-5(Feb 1972). (In Russian).

The diffusion and solubilities of nitrogen, oxygen, and CO_2 at various temperatures in poly(vinylidene fluoride), poly(trifluorochloroethylene), and copolymers of vinylidene fluoride with tetrafluoroethylene, with hexafluoropropylene, and with trifluorochloroethylene are described in terms of dosage of γ radiation (up to 800 MR) in a vacuum. (tr-auth)

7939 IRRADIATION BEHAVIOR OF GRAPHITE AT HIGH TEMPERATURE (A REVIEW). Engle, G. B. (Gulf General Atomic, Inc., San Diego, Calif.); Eatherly, W. P. High Temp. - High Pressures; 4: No. 2, 119-58(1972).

The irradiation behavior of reactor graphites at high temperatures (500 to 1400°C) to high fluences (up to 4×10^{22} n cm^{-2}) is reviewed, with emphasis on data generated during the period 1965 through 1971. The review covers graphite manufacture, irradiation damage, dimensional and structural changes, thermal expansion, thermal conductivity, Young's modulus, strength, and irradiation-induced creep. (auth)

7940 HEAT OF WETTING OF AN IRRADIATED FIBER FRAMEWORK. Usmanov, Kh. U.; Vakhidov, N. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 8, 35-6(1971). (In Russian).

Carefully weighed fiber frames of cellulose were given 1.5×10^6 R doses of gamma radiation from a ^{60}Co source both in vacuum and in air. The heat of wetting the irradiated samples was greater than for the controls (unirradiated), and the increment further increased during the following 12-day storage of the irradiated samples in air. After 12 days a decrease of the wetting heat was noted, continuing until the 20th day; no further change occurred during the next 100 days, although the value did not retreat to that of the control sample. (K.S.W.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

7941 (GULF-RT-A-12135) APPLICATION OF PHOTO-INDUCED REACTIONS TO NUCLEAR MATERIALS SAFEGUARDS PROBLEMS. Quarterly Progress Report, January 1, 1972–March 31, 1972. Bramblett, R. L.; Costello, D. G.; Ginaven, R. O.; Naliboff, Y. D.; Rundquist, D. E.; Trimble, G. D. (Gulf Radiation Technology, San Diego, Calif.). 12 Sep 1972. Contract AT(04-3)-167. 18p. Dep. NTIS.

Research and development performed by Gulf Radiation Technology during the period January 1, 1972 to March 31, 1972, on techniques and applications of nondestructive measurement of nuclear materials are reported. During this quarter the mobile assay system (GAMAS), equipped with the new barrel scanner and detector systems, was used for field operations at the Bettis Atomic Power Laboratory (BAPL). Results are given for the active and passive assay of the several categories of fuel-bearing material measured at BAPL. The Hewlett-Packard multichannel analyzer was interfaced to the HP 2116B computer in GAMAS for the purpose of simultaneous acquisition of data from both the neutron and the Ge(Li) detector system, and provision for computer analysis of the Ge(Li) spectra during periods in which the computer is not needed for the other operations. (auth)

7942 BASIC TECHNICAL PRINCIPLES OF INTERNATIONAL CONTROL OF NUCLEAR MATERIALS. Shmelev, V. M. At. Energ. (USSR); 33: No. 5, 883-8(Nov 1972). (In Russian).

The basic technical principles and procedures of IAEA safeguards under NPT conditions are summarized. The verification of nuclear materials is defined as the decision sequence relative to quantities and locations of nuclear materials. This verification could be achieved by the application of three basic safeguard measures, i.e., material balance accountancy, containment, and surveillance. The control process is presented as consisting of four stages: (1) use of records and reports; (2) verification by independent measurements; (3) evaluation of significant unaccountability of nuclear material; and (4) use of containment and surveillance as safeguard measures. (auth)

Disposal and Storage

Refer also to abstracts 7487, 7490, and 7558.

7943 (BNWL-1673) COMPATIBILITY OF CESIUM CHLORIDE AND STRONTIUM FLUORIDE WITH CONTAINMENT MATERIALS. Fullam, H. T. (Battelle Pacific Northwest Labs., Richland, Wash.). Oct 1972. Contract AT(45-1)-1830. 151p. Dep. NTIS.

In the Hanford Waste Management Program Sr and Cs will be recovered from the high-level Purex Acid Waste. Each element will be purified, converted to the appropriate chemical form, and doubly encapsulated for subsequent underwater storage. Strontium fluoride and cesium chloride were the chemical compounds selected for storage. An extensive compatibility program was carried out to select the best encapsulating materials. The tests were run using both radioactive and inert compounds. The radioactive tests were carried out at 400°C for periods up to one year. The nonradioactive tests were carried out at 400 and 800°C with SrF_2 and 400 and 600°C with CsCl. The nonradioactive tests lasted up to three years. Analysis of the test capsules showed 316L stainless steel is the best material for containing CsCl. Haynes 25 is the best material for containing the SrF_2, but Hastelloy C is almost as good. Estimates of long-term attack, based on the short-term data, show that both compounds can be adequately contained for the required storage period (~600 years) using 316L stainless steel for CsCl and Haynes 25 or Hastelloy C for SrF_2. (auth)

7944 (COO-1057-58) PETROFABRIC CHANGES IN HEATED AND IRRADIATED SALT FROM PROJECT SALT VAULT, LYONS, KANSAS. Holdoway, K. A. (Kansas Univ., Lawrence (USA). Radiation Physics Lab.). 30 Jun 1972. 73p. Dep. NTIS.

Rock salt was heated and irradiated in situ by implanted radioactive wastes during the Project Salt Vault experiment which was carried out at Lyons, Kansas, in the abandoned Carey Salt mine between 1965 and 1967. It was found that irradiation results in coloration of the salt, producing colors ranging from blue-black nearest the radiation source, to pale blue and purple farther from the source. Bleached areas are common in the radiation-colored salt, many representing trails produced by the migration of fluid inclusions towards the heat source. These visible trails are thought to have formed during the cooling down of the salt after the removal of the heaters and radiation sources. The distribution of primary structures in the salt suggests that little migration, if any, occurred during the course of the experiment. It is proposed that radiolysis of the brine within the inclusions may have led to the production of gases which impeded or prevented migration. Evidence of strain was observed in slip planes at 4 in. and between 5.5 and 10 in. from the array hole. Deformed bleached areas in the salt between the areas where slip planes are developed suggest that slight plastic deformation or flow may have occurred at 6 in. from the array hole. Differential thermal analysis shows that the maximum amount of stored energy also occurs at 6 in. from the array hole. This region may therefore represent the zone where the combined effect of stress and radiation was greatest. (auth)

7945 (IAEA-R-660-F) STUDIES ON LEACHING OF RADIOACTIVITY FROM GLASSES. Part of a Coordinated Programme of Research in Incorporation of Radioactive Wastes in Leach-Resistant Solids. Final Report, August 1, 1968–October 14, 1970. Levi, J. W. (International Atomic Energy Agency, Vienna (Austria)). Sep 1970. 31p. (HMI-B-95). INIS.

The self-diffusion of Na and Cs by heterogeneous isotope-exchange was measured using a new experimental method; this being with a view to the leaching of radionuclides from waste concentrates of glass. The experiments were performed by what are known as equilibrium salt melts. Under these conditions the measurement of the isotope-exchange is not disturbed by the concurrent ion-exchange. It was established that Na and Cs diffusion can be described by a uniform volume diffusion process. The activation enthalpy of Cs diffusion (for Na this has not been investigated) depends characteristically on the composition of the glass (mixed alkali effect). (INIS)

7946 (KURRI-TR-104) INSTRUMENTATION AND CONTROL SYSTEM OF RADIOACTIVE WASTE TREATMENT FACILITIES IN THE RESEARCH REACTOR INSTITUTE, KYOTO UNIVERSITY. Tsutsui, T.; Shimoura, K. (Kyoto Univ. (Japan). Research Reactor Inst.). 1972. 46p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The radioactive waste treatment facilities at the Research Reactor Institute, Kyoto University, consist of four main processes such as evaporation, chemical precipitation–filtration, ion–exchanger and freezing–thawing of sludge. Detailed design and drawings of control systems for these processes are presented. Operation and maintenance of the systems are also discussed. (auth)

7947 TREATMENT AND STORAGE OF RADIOACTIVE SOLID WASTES DERIVED FROM THE NUCLEAR POWER STATIONS IN THE NETHERLANDS. Atoomenergie Haar Toepass.; 14: 235-48(Sep 1972). (In Dutch).

A forecast is given of the amounts of radioactive wastes to arise from the operation of nuclear power stations in the Netherlands. Various treatment and storage methods are compared and as the best solution for low and medium level solid wastes storage in a solution-mined cavity in rock salt is proposed. Possibilities for storage of high-level wastes are also indicated. (auth)

Handling Equipment and Procedures

7948 (AEC-tr-7390) INFORMATION ROBOTS AND MANIPULATORS. Katys, G. P.; Mamikonov, Yu. D.; Il'inskii, V. M.; Karyagin, O. I. Translation of Informatsionnye Roboty i Manipulyatory, Energiya Press, Moscow, 1968. 37p. (JPRS-48698). Dep. NTIS.

Information robots, manipulation systems, application of informational robots, and means of propulsion of informational robots are described. This information consists of excerpts from the original publication. (J.R.D.)

7949 RADIOACTIVE AEROSOL PRECIPITATION IN THE RESPIRATORY SYSTEM. Bykhovskii, A. V.; Zaraev, O. M.; Rakhmanov, B. N. Gig. Sanit.; No. 9, 46-50(Sep 1972). (In Russian).

In order to achieve valid radiation-protection interpretations of given work conditions that are contaminated by radioactive aerosols, it is necessary to control the radioactivity of the air by individual sampling in conjunction with measurements of the distribution of radioactivity of the aerosol in accordance with the aerodynamic dimensions of the particles. A multicascade

impactor assists in establishing the distribution of radioactivity directly according to particle size. The design and construction of a six-cascade impactor made of stainless steel is discussed. (K.S.W.)

7950 CREEP MACHINE FOR HOT CELL USE (Engineering Materials). (Oak Ridge National Lab., TN). (CAPE–2293). 2 drawings.

The design of a remotely operated creep machine is described. Specimens 2 in. long with ¼-in.-dia heads and 1-in.-gage sections ⅛ in. in dia have been run at temperatures as high as 760°C and at loads up to 60,000 lb per sq in. in the machine. Furnace adjustment and calibrations give uniform temperatures. Specimen extension is monitored by a dial gage and a LVDT that feeds an automatic data gathering system. The principal features of the machine include weight loading in front of the specimen and suspension of the furnace from the movable stringer rod. The creep machine, control system, calibration procedures, and remote operation are described with emphasis on mechanical design. These machines, with load-to-stress ratio of either 6 to 1, 10 to 1, or 20 to 1, have been installed in two 6 ft by 11 ft cells that have two pairs of master slave manipulators and two windows per cell; each manipulator pair is used to service 6 creep machines. (auth)

7951 LABORATORY FITTINGS AND WASTE SYSTEMS. Hughes, D.; Cullingworth, R. (Univ. of Leeds, Eng.). Chem. Brit.; 8: No. 11, 470-4(Nov 1972).

Attention to detail is of the utmost importance when designing or adapting laboratories for work with open sources of hazardous materials, whether they be radioactive substances, carcinogens or other chemical toxins. Some points of detail that must be considered regarding laboratory fittings and waste systems are discussed. (auth)

7952 COLLECTION OF PARTICULATE MATTER FROM SMOKESTACKS USING GAMMA-RAY IONIZATION. Schultz, M. A.; Crotzer, M. E.; Knapick, W. R. (Pennsylvania State Univ., University Park). Nucl. Technol.; 17: No. 1, 38-48(Jan 1973).

When gamma rays are used to charge particulate matter in stack gas, high collection efficiencies are obtained. These high efficiencies are achieved for all sizes of particulates, including those of sub-micron size. The latter represents a significantly different result from that of the conventional Cottrell electrostatic precipitator with its corona ionization rather than gamma-ray ionization. A charge separation theory is suggested as the reason for collecting equal numbers of positively and negatively charged particles. An experimental test rig is described using 10,000 curies of cobalt-60, and a conventional stoker fed furnace. (auth)

7953 STORAGE CONTAINER FOR FISSILE MATERIALS. Schuske, C. L.; Hunt, D. C. (Dow Chemical Co., Golden, CO). Nucl. Technol.; 16: No. 3, 562-5(Dec 1972).

A fissile storage container made of non-flammable materials is described which utilizes a thick moderator such as water to enclose each storage unit in a container array. The internal moderator serves three basic functions: (1) it partially isolates adjacent storage units from one another in an array of units, thus permitting high vault loadings, (2) it substantially reduces the ambient dose rate in the storage area, and (3) it reduces the temperature of the stored fissile material. The use of the containers in the storage of 3 kg plutonium metal cylinders is described. In this application, the ambient total dose rate (neutron plus gamma) is reduced a factor of approximately eight (8) and the cylinder temperature reduced approximately 30°F over the corresponding temperature for storage in an unshielded metal container. Multiplication factor calculations show that a $5 \times 5 \times 5$ array of the containers is well sub-critical even with twenty-seven (27) containers in the center of the array double loaded. (auth)

Transportation

Refer also to abstract 7953.

7954 (NP–19605) TRANSPORTATION OF NUCLEAR SPENT FUEL. Administrator's Guide No. 3. (Southern Interstate Nuclear Board, Atlanta, Ga.). 1972. 111p.

The operational and regulatory aspects of transporting nuclear spent fuel from the reactor, from which it was removed, to the reprocessing plant where the unused fuel is recovered for re-use are presented. Nuclear power plants which are now operating or on order are listed. Transportation requirements are projected for the next ten years in terms of tons of radioactive cargo to be shipped from a reactor to a reprocessing plant. Nuclear fuel characteristics and typical fuel assemblies for present-day reactors are described. Applicable federal and state regulations and regulatory agencies are listed. The various transportation modes — highway, rail, and water — that are available for spent fuel shipment are discussed, along with their limitations. Typical shipping containers for spent fuel assemblies are described and the AEC licensing requirements are listed. Finally, the report concludes with a discussion of safety considerations. (T.F.D.)

7955 SYSTEM FOR PROTECTING RADIOACTIVE SOURCES AGAINST DUSTS AND UNDESIRABLE SUBSTANCES. Hours, R. (to Commissariat a l'Energie Atomique). French Patent 2,109,008. 26 May 1972. Filed 30 Oct 1970. (In French).

A system for protecting weakly penetrating α particle sources (the type consisting of a radioactive product in a box) from mechanical shocks and atmospheric dusts is presented. The box is closed by a removable grid/thin screen combination (which is easily replaced), positioned between the source and the grid in such a way that it does not come into contact with the radioactive source. An additional use of the screen is to avoid the contamination of the user's fingers. The interchangeable screen is in the form of a metallic, plastic, or textile screen. (France)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 8222 and 8677.

7956 NEUTRON PRODUCTION FROM ELECTRON ACCELERATORS USED FOR MEDICAL PURPOSES. Axton, E. J.; Bardell, A. G. (National Physical Lab., Teddington, Eng.). Phys. Med. Biol.: 17: No. 2, 293-8(Mar 1972).

The photoneutrons produced in the target and collimating assemblier of electron accelerators contribute a whole body neutron dose to the patient undergoing radiotherapeutic treatment; there is an additional contribution from any photoneutrons produced by high energy photons incident on the patient. Although the upper limit of neutron dose equivalent rate (NDER) can be estimated at about 1.5% of the central axis x-ray absorbed dose rate, it was feared that the neutron dose rate outside the useful beam area might be a significant fraction of that within it, and give rise to whole body neutron damage. To investigate the possibility, activation measurements were made for dose rates from a Brown Boveri 35 MeV betatron. Gold foils mounted in polythene spheres were calibrated for two different neutron energies at N.P.L. and their efficiencies estimated for the mean photoneutron energy of 2.5 MeV. The measured NDER was 0.6% of the absorbed x ray dose rate. On the basis of the results it is calculated that a patient receiving 6000 rads would experience a whole body neutron maximum dose equivalent as a result of neutrons outside the treatment field of 10 rem in the x ray mode and 0.6 rem in the electron mode. Comparable results were also obtained using a linear accelerator operating at 16 MeV, suggesting that they are not strongly dependent on accelerator energy. (UK)

7957 HIGH-CURRENT RELATIVISTIC ELECTRON BEAM ACCELERATORS AT CORNELL UNIVERSITY. Clark, J. J.; Ury, M.; Andrews, M. L.; Hammer, D. A.; Linke, S. (Cornell Univ., Ithaca, N. Y.). Contract N00014-67-A-0077-0003. pp 117-30 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From tenth symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

The accelerator consists of a slow energy store (conventional Marx generator) discharging into a submicrosecond store (planar transmission line), which is fast switched to produce a 50-ns pulse. An end-fed planar diode, using a plasma cathode, injects the electron beam through a thin anode foil into a drift space. The system is normally operated at a rate of three to four firings per hour. The diode operational characteristics and time-integrated current distribution studies and time-differentiated current distribution studies of the electron beam at the plasma cathode are described. (W.H.K.)

7958 45 MeV BETATRON FOR RADIATION THERAPY. Maikoff, N.; Sempert, M. (Brown, Boveri and Co. Ltd., Baden, Switzerland). Acta Radiol., Suppl.; No. 313, 95-104(1972).

From sixth conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

The new betatron installation for radiation therapy, the Asklepitron 45, with a maximum energy of 45 MeV is described. In particular the mobility and the setting possibilities are dealt with. Radiation measurement and automation with punched card control increase the reliability, shorten the setting-up time and a computer facilitates recording and evaluation. (auth) (Sweden)

7959 NEW LINEAR ACCELERATOR FOR RADIATION THERAPY. A PRELIMINARY REPORT. Netteland, O. (Norske Radiumhospital, Oslo). Acta Radiol., Suppl.; No. 313, 105-16 (1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

The need for small and simple clinical linear accelerators is discussed and principal specifications for such an apparatus are given. A new 4 MeV linac is described, especially characterized by a new rotating gantry, a new roentgen ray head and a fundamentally new Pretzel bending magnet system, which give a simple construction of the accelerator with very high inherent stability for both electric and mechanic variations. Some results of recent technical and radiophysical performance tests are given, indicating that the new accelerator has qualifications to be a useful and economic equipment for practical radiation therapy. (auth)

7960 TEN YEARS OF ACCELERATOR PHYSICS. Kirk, T. B. W.; Wilson, R. (Harvard Univ., Cambridge, MA). Rep. Progr. Phys.; 35: No. 5, 529-85(1972).

A review (completed in November 1971) is presented of ten years of accelerator physics. During that time high energy physics has made many discoveries. Coulomb's law has been shown to hold at distances down to less than 10^{-14} cm—smaller than the size of the proton. Since parity violation was first observed in 1957, weak interactions have become an enormous field. From the simple Fermi theory of beta decay the existence of two neutrinos has now been shown and the exact form of the interaction has been demonstrated. The superweak interaction has been found, a thousand times weaker than the Fermi interaction and violating time reversal invariance. This is beautifully demonstrated by precise experiments with neutral K mesons. The many hundreds of elementary particles have been shown to be grouped in mass and quantum numbers according to a symmetry scheme SU3. There are many beautiful tests of this symmetry. The description of it in terms of a quark of charge e/3 has not yet had experimental confirmation. The nucleon is yielding to study. Inelastic electron scattering shows that a nucleon consists of internal objects called partons. Whether these are the quarks of the symmetry rules is not yet known. It is likely that the next ten years will be more exciting still. At higher energies weak interactions will reach the unitary limit and the theory will break down; with smaller wavelength probes the inside of the nucleon will yield its secrets. (auth)

Auxiliaries and Components

Refer also to abstracts 7631, 8555, and 8888.

7961 (BNL-17193) NEW SUPERCONDUCTING MATERIALS FOR MAGNET APPLICATIONS. Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). [nd]. 6p. (CONF-720908-15). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY. (19 Sep 1972).

The "state of the art" for niobium titanium composite conductors is reviewed. The properties of multifilamentary A15 conductors are described and compared with those of NbTi composites. (auth)

7962 (BNL-17196) STATIONARY COIL FOR MEASURING THE HARMONICS IN PULSED TRANSPORT MAGNETS. Morgan, G. H. (Brookhaven National Lab., Upton, N. Y.). [nd]. 4p. (CONF-720908-10). Dep. NTIS.

From 4th international conference on magnet technology; Upton, NY. (19 Sep 1972).

Coil configurations sensitive mainly to a single multipole have been constructed and tested, and the performance is substantially as predicted. The coils may be used either by rotating in a static field or stationary in a pulsed field; the former method is part of the procedure for determining constructional errors. The theory is summarized and procedures for calibrating and compensating for constructional errors are given. (auth)

7963 (BNL-17249) BEAM DIAGNOSTICS AT THE BNL 200 MeV LINAC. Fewell, N.; Witkover, R. (Brookhaven National Lab., Upton, N. Y.). [nd]. 17p. (CONF-721046-6). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

The location, utilization, and performance of the beam monitors, including current transformers, SEM profile monitors, multiwire SEM's, emittance probes, and non-destructive emittance measurements are described. Also, the rf buncher energy monitor, beam position monitors, and data processing and displays are discussed. The layout of the complete system is shown. (W.H.K.)

7964 IMPORTANCE OF TWO INDEPENDENT INTEGRATING MONITORING SYSTEMS IN MEDICAL ACCELERATORS. Lindskoug, B.; Bengtsson, G.; Svensson, H. (Univ., Goteborg). Acta Radiol., Suppl.; No. 313, 90-4(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

The experience from a dual monitoring system used with a BBC 35 MeV betatron is reported. It is found that acute faults appear which may cause significant changes of the given dose. (auth) (Sweden)

7965 RESONANT CAVITIES THAT ARE FREQUENCY INSENSITIVE TO AXIAL ELONGATION. Aboul-Atta, O. A.; Tomchuk, E. (Univ. of Winnipeg, Manitoba). Can. J. Phys.: 50: No. 15, 1711-8(1 Aug 1972).

Microwave power is used to accelerate particles by allowing them to pass through a structure of coupled cavity resonators (standing wave linear accelerators). To accelerate the particles to high velocities over a short length, these accelerators must have a nonperiodic structure because the cell length ought to vary gradually according to the particle velocity. As the resonance frequency of all cells must be the same, the search for those particular cells that are frequency insensitive to axial elongation is of considerable importance. This phenomenon is found in some cylindrically symmetric cavities which are also symmetric about a middle plane perpendicular to the axis of symmetry (meridian of symmetry). They can be stretched axially by an additive cylindrical (tube) section in the middle without need for retuning provided that the average electromagnetic energy is perfectly balanced at that middle plane. Also the work presented here yields the theoretical answers to both the justification of the frequency insensitive phenomenon and the existence of such resonant cavities. As the mathematical conditions are related to the electromagnetic energy density at the meridian of symmetry, they are concurrently interpreted physically. (auth)

7966 FOCUSING DEVICE FOR AN ISOCHRONOUS CYCLOTRON. Delphin, P.; Peironet, P. (to Thomson-CSF). French Patent 2,109,273. 26 May 1972. Filed 9 Oct 1970. (In French).

A focusing device for an isochronous cyclotron particle accelerator is described. The particular configuration of the electromagnetic pole pieces enables large variations in the magnetic field occurring at the edges of the pole pieces to be avoided. (France)

7967 FAST-CLOSING VALVE SYSTEM FOR CYCLOTRONS. Hahn, Richard L.; Stone Roland L.; Tarrant, James R.; Hunt, Lee D. (to United States Atomic Energy Commission). U. S. Patent 3,675,072. 4 Jul 1972. Filed 28 Jan 1971.

A fast-closing valve system has been provided which operates to protect a cyclotron from loss of vacuum and backwash of radioactive contamination when using intensely alpha-active actinide targets. The valve portion consists of a valve chamber adapted for mounting in a beam tube and having aligned ports on opposite sides through which the accelerated particle beam travels. A valve gate is slidably mounted in the valve chamber between the ports and normally urged into a seated position, closing the ports, by means of compression springs. The valve gate is held open by means of an electromagnet and, when the current to the electromagnet is suddenly shorted, the magnetic field rapidly collapses and the springs slam the valve gate into the seated position. The circuit controlling the actuation of the electromagnet uses a spark plug as a pressure sensor mounted in the beam tube, downstream of the valve and when a slight pressure rise in the beam tube occurs the spark plug fires triggering the control circuit which, in turn, shorts the electromagnet. A plurality of annular baffles are mounted in the beam tube to retard the shock wave from pressurized gas backwash in the case of an accident, such as a target rupture, allowing the valve to close before the gas reaches the valve assembly. (auth) (Official Gazette)

Ion Sources and Injection and Extraction Systems

7968 (LA-DC-72-1066) OBSERVATIONS AND CALCULATIONS FOR A DUOPLASMATRON WITH EXACT PIERCE EXTRACTION. Emigh, C. R.; Mueller, D. W. (Los Alamos Scientific Lab., N. Mex.). [nd]. 6p. (CONF-720948-1). Dep. NTIS.

From second international conference on ion sources; Vienna, Austria (11 Sep 1972).

The spreading effect from the motion of thermal agitation of ions in a duoplasmatron with exact Pierce extraction at the LAMPF Proton Injector was studied. Results indicate an ion temperature in the 0.3 to 1.46 eV range. Much larger beam spreading would result from higher temperatures. The ion temperature of 1.46 eV is consistent with the accepted emittance of the LAMPF H^+ beam, which is 1.53 eV. (F.S.)

7969 PRODUCTION AND DIAGNOSTICS OF HIGH-CURRENT PULSED RELATIVISTIC ELECTRON BEAMS. Condon, J. J. (Naval Research Lab., Washington, D. C.). pp 131-42 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From tenth symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

The work on high-current diodes used for the generation of electron beams at the Naval Research Laboratory is reviewed. The methods for measuring voltage and current of the pulse supplied to the diode and procedures used to calibrate the voltmeters and the current meter are outlined. Types of cathodes which have been examined and the diagnostic methods which were used to measure their characteristics are described. Comparison is made between available theoretical predictions and the experimental values. (auth)

7970 BEAM CHARACTERISTICS OF INTENSE RELATIVISTIC ELECTRON ACCELERATORS. Uglum, J. R.; McNeill, W. H.; Graybill, S. E. (Ion Physics Corp., San Leandro, Calif.). pp 155-63 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From tenth symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

Time-resolved and time-integrated diagnostic tools which have been developed at Ion Physics Corp. for measuring the injection parameters of intense relativistic pulsed accelerators are reviewed. Topics include beam current measurements, electron energy, total beam energy, current density profiles, divergence and emittance, and computer predictions. (W.H.K.)

7971 DEVICE FOR BUNCHING THE PARTICLES OF LINEAR ACCELERATOR BEAMS. Tronc, D.; Leboutet, H. (to Thomson-CSF). French Patent 2,110,799. 2 Jun 1972. Filed 30 Oct 1970. (In French).

A device for bunching particles is described. It consists of at least one cylindrical microwave cavity. The particles traverse this cavity parallel to its axis. The distance L between the input and output faces of the cavity is linked to the mean velocity v of the particles and the frequency of operation of the device f by the following formula: $L = nv/f$, n being a numerical factor lying between 0.5 and 1.5. (France)

7972 IMPROVEMENT TO ION SOURCES. Moreau, J. (to Societe Generale de Constructions Electriques et Mecaniques). French Patent 96,127. 19 May 1972. Filed 25 Nov 1968. (In French).

An improvement to previously described ion sources is described. An electron beam produced by an elongated filament penetrates an ionization chamber perpendicular to the direction of a magnetic field through a slit elongated in the direction of this magnetic field. (auth)

7973 IMPROVEMENTS TO THE POWER TRANSFERRING DEVICES OF INSTALLATION OPERATING AT VERY HIGH VOLTAGES. Roux, J.; Martin, J. (to Agence Nationale de Valorisation de la Recherche). French Patent 2,106,643. 5 May 1972. Filed 18 Sep 1970. (In French).

A system for transferring power between two zones having a substantial dc potential difference between them is described. The principal application of the system is the power transference between the floor and dome enclosing the heavy ion source of a linear accelerator. The system utilizes N electrical transformers positioned between the first and second zone in such a way that the secondary coil of a transformer feeds the primary coil of the adjacent transformer. These transformers are designed to be capable of handling a fraction V/N of the pd between the zones. A suitable potential divider applying across the successive transformers successively increasing potential differences (multiples of V/N) is envisaged. (France)

7974 PROPERTIES OF A HIGH CURRENT, LONG LIFE LITHIUM ION SOURCE. Moeller, W.; Kamke, D. (Ruhr Univ., Bochum, Ger.). Nucl. Instrum. Methods; 105: No. 2, 173-7(1972).

The design and preparation of a Blewett–Jones-type lithium ion source is described. Measurements of ion current, lifetime, ion energy distribution, and beam emittance are reported and discussed. (auth)

7975 NEUTRON PRODUCTION AND COLLECTIVE ION ACCELERATION IN A HIGH-CURRENT DIODE. Bradley, L. P.; Kuswa, G. W. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett.; 29: No. 21, 1441-5(20 Nov 1972).

New measurements demonstrate that neutrons produced in a high-current pulsed diode with deuterium-bearing electrodes are of beam-target origin. During a brief portion of a 70-nsec, 2-MV, 50-kA pulse, positive ions from the anode and cathode plasmas

were observed to be accelerated toward the anode rather than the cathode as dictated by the externally applied field. Energetic deuterons were observed, behind a small aperture in the anode, which were the source of neutrons produced with Li or C anodes. (auth)

Ion Optics and Field Calculations

Refer also to abstracts 7999 and 8892.

7976 (LA-5075) COMPUTATION OF MAGNETIC END FIELDS, AND COMPARISON WITH MEASUREMENT. Vogel, H. F.; Lari, R. J. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 4p. Dep. NTIS.

The dependence of the magnetic effective length and the fringe-field correction constant on the central field flux density are of particular interest in designing beam transport systems. It is therefore important to know the accuracy with which they may be calculated. Measurements on Argonne's bending magnet BM-111 have been compared with TRIM computations. The agreement between computed and measured effective lengths was within 1.7 percent in pole separation units for fields from 0 to 17 kG. The agreement between computed and measured fringe field correction constant, which determines the correction angle to the transverse focal length, was within 0.56 percent of the measured value of 8 kG. (auth)

7977 EXPERIMENTAL INVESTIGATIONS OF HIGH ν/γ BEAM TRANSPORT. Yonas, G.; Spence, P. (Physics International Co., San Leandro, Calif.). pp 143-54 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From tenth symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

Experimental and analytical studies of the generation and propagation characteristics of intense relativistic electron streams where the beam self-magnetic field is sufficiently large so that paraxial electron trajectories cannot exist are discussed. Beam transport properties are related to current neutralization and current neutralization is related to the time dependence of the beam currents in terms of the electromagnetic fields generated by the beam-plasma system. A diode and drift chamber with a Marx generator pulser was used to generate electron beams at 180 keV to 1 MeV at mean current levels of 200 to 100 kA with a 50 ns pulse duration for the study. (W.H.K.)

7978 MEASUREMENT OF MAGNETIC FIELD. A BIBLIOGRAPHICAL REVIEW. Verma, J. K. D.; Raju, V.; Aggarwal, M. D. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Instrum. Methods; 104: No. 3, 545-74(1972).

The accuracy attained and the limitations of the various methods of measuring magnetic fields are discussed. A bibliographic compilation of about 550 references which are divided into three parts: magnetic field measurement in the laboratory, in accelerators and beam-handling magnets, and of earth and extra-terrestrial bodies, is given. These are arranged in chronological order under the heading of each particular method. (auth)

7979 HIGH ORDER ABERRATIONS FOR ION ORBITS IN STATIC MAGNETIC FIELDS. Tautz, M. F. (Northeastern Univ., Boston). Nucl. Instrum. Methods; 104: No. 3, 505-7 (1972).

It is shown that the Nth order aberrations for ions in paraxial orbits in static magnetic fields can be systematically calculated via quadratures. The computation scheme is quite general, the only limitation being that the fields must satisfy some (not very) restrictive conditions. (auth)

7980 PARTICLE BEAM ANALYZER AND CALIBRATION DEVICE. Cortial, H. (to Commissariat a l'Energie Atomique). French Patent 2,108,860. 26 May 1972. Filed 13 Oct 1970. (In French).

An analyzer, which can perform a continuous point exploration of the entire beam, and stops automatically at a position outside the beam after the analysis, is described. The analyzer does not possess any cooling fluid and is compact. It is rapidly set into operation and economic to use. (France)

7981 IMAGE OF AN OFF-AXIS POINT SOURCE IN A CYLINDRICAL-MIRROR ELECTROSTATIC ANALYZER. Zashkvara, V. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 5, 777-81(Nov 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 5, 981-6(May 1972).

Second-approximation calculations are made of the image of an off-axis point source in a cylindrical mirror which focuses charged particles with an annulus-axis ion-optical system. (auth)

Storage Rings

7982 (BNL-17239) VACUUM SYSTEMS FOR SUPERCONDUCTING STORAGE RINGS. Bittner, J. W.; Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). 28 Sep 1972. 5p. Dep. NTIS.

Based on present knowledge, the warm vacuum chamber appears to have many advantages such as simpler single wall construction, fewer welds, well tested components, smaller thermal stresses and higher conductance. Most significant perhaps is the experience with ISR at CERN which shows that the proposed warm system will work. Its only disadvantage is the increase in cost of a slightly larger aperture superconducting magnet. There are, however, two areas which require a good deal of experimental work, namely: development of methods to achieve clean surfaces and low desorption coefficients in Al and Cu pipes when bombarded by ~1 keV ions, and design of a cryosorption pump to be used between magnets inside the dewar. Operating the vacuum chamber at 4.2°K could result in much lower gas densities which in turn would reduce the cost of superconducting magnets by decreasing their aperture. Unfortunately, very little information is available on cold surfaces at the present time and one can never eliminate all vacuum leaks. Experiments will be carried out to study desorption of various frozen gases from cold Al and Cu. It might be very useful to insert a cold section of beam pipe in an existing storage ring such as the ISR at CFRN, to answer the crucial question of desorption and readsorption on cold surfaces under true operating conditions. Unless one of the experiments yields more encouraging results, the vacuum chamber in storage rings should not be operated at liquid helium temperature. (auth)

7983 (BNL-17369) CONTROLLING NONLINEAR RESONANCES IN SUPERCONDUCTING STORAGE ACCELERATORS. Parzen, G. (Brookhaven National Lab., Upton, N. Y.). 31 Oct 1972. 12p. Dep. NTIS.

There is reason to expect that nonlinear imperfection resonances may be stronger in a high field superconducting storage accelerator than in a storage accelerator using conventional magnets. A rough study is done to estimate the minimum correction magnets required to correct for resonances up to and including the fifth order. It may be sufficient to have roughly one correction magnet in each cell of the storage ring, with each correction magnet having 12 different coils which are independently excited, and with about 36 independent power supplies. It is also suggested that these correction magnets may be used as all-purpose correction magnets and correct for the linear resonances, central orbit displacements, and move the working point ν_r, ν_z as well. In this case, about two correction magnets are required per cell, each correction magnet having 21 different windings, and with about 132 independent power supplies required. (auth)

7984 (BNL-17370) NEUTRONS FROM ISABELLE. Devlin, T. J. (Brookhaven National Lab., Upton, N. Y.). 7 Nov 1972. 4p. Dep. NTIS.

If ISABELLE is operated with deuterons, a substantial fraction of the total beam energy will go into tightly collimated neutron beams from stripping reactions. Provision should be made to protect machine components from concentrated radiation of this type. The beams will be largely mono-energetic at one-half the deuteron beam energy. It is possible that useful physics experiments could be performed in such a beam, and some of its parameters are computed. Neutron beam characteristics, intersection design, beam dump considerations, and a neutron-proton colliding beam scheme are discussed. (W.H.K.)

7985 OPERATION OF THE ISR FACILITY IN RELATION TO THE UHV ENVIRONMENT. Jones, E. (European Organization for Nuclear Research, Geneva). Vacuum; 22: No. 8, 299-302(Aug 1972).

At CERN Geneva, two kilometers of UHV at 10^{-10} torr is in daily use at the Intersecting Storage Ring (ISR) facility. An appreciable fraction of the stainless steel vacuum chamber, some 200 m in fact, is continuously at 10^{-11} torr. Beams of many amperes of 28 GeV protons circulate for many hours inside the ISR vacuum chambers. A vacuum of 10^{-10} torr is essential if the protons are to remain unperturbed by collisions with the residual gas molecules. However, when the beam current is allowed to exceed about 5 A, certain regions of the vacuum chamber surface appear to desorb gas molecules and the pressure rises to values in excess of 10^{-7} torr. Mechanisms which might give rise to such pressure increases are discussed along with general problems related to the production and maintenance of large scale UHV systems. (auth)

Experimental Facilities

Refer also to abstract 8541.

7986 (DNPL/R-22) ADAPTATION OF THE DARESBURY LABORATORY EXPERIMENTAL MAGNET AND POWER SUPPLY SYSTEM TO COMPUTER CONTROL. Johnstone, W. T.; Silversides, R. W. (Daresbury Nuclear Physics Lab. (England)). 1972. 28p. Dep. NTIS (U. S. Sales Only).

Plans for computer control of the beam lines at the Daresbury Synchrotron are described. Topics include preparing a single power supply, basic considerations for control system hardware, equipment and modifications, and operation of the system. (W.H.K.)

7987 (IFVE-OP-71-111) PROTON BEAM FOR THE LIQUID HYDROGEN BUBBLE CHAMBER "MIRABELLE". Galyaev, N. A.; Golovnya, N. I.; Grachev, M. I.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

A description of an optical scheme of the beam channel for shaping the proton beam which is elastically scattered on the internal target of the French bubble chamber "Mirabelle" is given. The main parameters of the proton beam ejection system and the one for particle monitoring are given. The characteristics of the proton beam with momentum up to 70 GeV/c are reported. (auth)

7988 (LA-5070) PROPOSED FAST ELECTRONICS FOR EPICS. Thiessen, H. A. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 9p. Dep. NTIS.

A block diagram has been prepared for the fast electronics for EPICS including beam monitors. The system should prove to be adequate for the first few experiments with the exception that no provision has been made for a differential Cherenkov counter. The comments and criticism of users during the summer of 1972 have been incorporated. (auth)

7989 (LA-5077) 3D MAGNETIC FIELD COMPUTATIONS AND COMPARISON WITH MEASUREMENTS. Christian, R.; Vogel, H. F. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 2p. Dep. NTIS.

3D calculations have been made for an H frame magnet mounted in a steel box for a d-c separator. In the computations, steel is assumed to be of infinite permeability. Measurements have been made on this magnet, which are compared with the computations. (auth)

7990 (LA-5079) PROPOSAL FOR EPICS DATA ACQUISITION SOFTWARE. Eisenstein, R. A.; Barnes, P. D.; Thiessen, H. A. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 23p. Dep. NTIS.

Software for the PDP-11 data acquisition system for the EPICS (Energetic Pion Channel and Spectrometer) channel at LAMPF is described. (W.H.K.)

7991 (LA-DC-72-1118) MAGNETIC MEASUREMENTS ON THE LASL PROTOTYPE MAGNET. Dunwoody, W.; Spencer, J.; Tanaka, N. (Los Alamos Scientific Lab., N. Mex.); Rolfe, R. (California Univ., Los Angeles); Stearns, R. (Vassar Coll., Poughkeepsie, N. Y.); Thomason, M. (Virginia Univ., Charlottesville). [nd]. 10p. (CONF-720908-6). Dep. NTIS.

From fourth international conference on magnet technology; Upton, N.Y. (19 Sep 1972).

A small dipole magnet has been designed and constructed for use as a prototype for the kinds of magnets to be used with the High Resolving Power Spectrometer (HRS) and the Energetic Pion Channel and Spectrometer (EPICS) facilities currently under construction at the Los Alamos Scientific Laboratory. Because of the wide range in uniform field strengths and the high degree of homogeneity which is required in these magnets, a more versatile method than pole face shims or homogenizers was considered necessary. A set of corrective current elements, called H_t-windings, were introduced inside the pole pieces of the magnet to provide dynamic correction of field inhomogeneities in the uniform field region. By successively varying these currents and plotting the resulting field distribution, $B_y(x)$, it was possible to reduce magnetic field variations of a few parts in 10^3 in the initial median plane distribution to a few parts in 10^5 over a range of induction fields of $B_o = 4$ to 17 kG. These initial results indicate that field homogeneities significantly better than 1 part in 10^5 should be possible with the appropriate number and distribution of H_t-current elements. (auth)

7992 (LA-tr-72-27) AUTOMATING A NUCLEAR PHYSICS LABORATORY BY COMPUTER. II. CLOSED LOOP CONTROL AND INTERFACE. Arnaud, A.; Garnier, Y.; Herbert, D.; Rion, J. Translated for Los Alamos Scientific Lab., N. Mex., from Nucl. Instrum. Methods; 93: 45-56(1971). 26p. Dep. NTIS.

The hardware used to operate a Van de Graaff accelerator and the associated experiments by means of a computer are described. The computer sets to the proper value before each run the following parameters: accelerator energy and positions of sample and detectors. Furthermore it starts and stops data acquisition. Regulating devices are used to control the Van de Graaff high voltage, the field of the magnetic analyzer, and the parameters of the magnetic bunching system. (auth)

7993 EXPERIMENTAL STUDY OF ISOMERIC NUCLEI WITH LIFETIMES IN THE MILLI- AND MICROSECOND RANGE. Uyttenhove, J. A. Ghent; Ghent Rijksuniversiteit (1971). 107p. (In Dutch).

Thesis.

A new measuring system for investigation on isomers in the milli- and microsecond region is described. The Bremsstrahlung of the 32 MeV 50 Hz linear electron accelerator of the Ghent University was used to produce isomeric states by photonuclear reactions. The aim of this system is to obtain simultaneously information about energy and decay-time of the excited levels. This is done by registration of the γ-ray spectra in a number of successive intervals after each beam burst. The use of a large Ge(Li) detector (50 cm^3) for good resolution and efficiency involves some electronic difficulties especially in the case of isomers with very short half-lives. This system is suitable for investigations down to 10 μs isomers. (auth)

7994 LIQUID DEUTERIUM TARGET. Blum, D.; Boucrot, J.; McGill, B.; (and others) (Univ. Paris, Orsay, France). Nucl. Instrum. Methods; 104: No. 3, 509-16(1972). (In French).

An original liquid deuterium target has been built at the Orsay Linear Accelerator Laboratory to study the interaction of monochromatic gamma rays of 400 MeV with deuterons. The description and the performances of the target and of the automatic system which provides it with liquid deuterium during several weeks, without any human intervention, are discussed. (auth)

7995 ANALYTIC APPROXIMATION OF THE DOSE DISTRIBUTION FROM A 6 MeV LINEAR ACCELERATOR. Hjelm-Hansen, M. (Radium Centre, Aarhus, Denmark). Acta Radiol., Suppl.; No. 313, 51-9(1972).

From 6th conference of the Nordic Association of Clinical Physics; Aarhus, Denmark (20 Aug 1970). See CONF-700860.

Following a procedure originally given by Sterling et coll. it is possible to obtain a simple mathematical expression for an approximate calculation of isodose curves below a plane surface. To calculate an isodose curve only the field size must be specified. The approximation is made by an expression of the per cent depth dose d_c on the central axis and another expression of the factor f_p by which d_c must be multiplied to yield the per cent depth dose at a point away from the central axis. Comparisons with measured isodose curves show agreement, usually better than 2.5 per cent. (auth) (Sweden)

7996 DISTRIBUTION OF SCATTERED ELECTRONS FROM AN 8 MeV LINEAR ACCELERATOR. Scrimger, J. W. (W. W. Cross Cancer Inst., Edmonton, Alberta). Radiology; 105: No. 2, 421-3(Nov 1972).

The intensity and distribution of scattered electrons from an 8 MeV medical linear accelerator using thermoluminescent dosimeters (LiF Teflon discs) are reported. When a 1.5 cm thick lucite sheet was placed in the beam, electrons were scattered from the lucite and resulted in a loss of build-up as measured in a water phantom. The extent of this loss was a function of field size and the distance of the lucite from the surface of the water. In addition, scattered electrons were detected outside the beam edges. The distribution and depth dose characteristics of these electrons were studied. (auth)

7997 SIZE SPECTRUM OF TITANIUM TRITIDE PARTICLES. Barta, Karel; Turek, Karel (Technical Univ., Prague). Jad. Energ.; 18: No. 10, 347(Oct 1972).

The detachment of titanium tritide particles from targets under various conditions of target handling was investigated. Particle diameter was visually determined at size intervals of from 1 to 100 μm using microscopic techniques. The value of released activity was estimated to be less than 3% of the initial target activity assuming all particles to be of cylindrical shape, with the height of the cylinder equal to the target's active layer and with the tritium homogeneously distributed through the active layer. (F.S.)

7998 ROTATING TARGET FOR AN ELECTROSTATIC ACCELERATOR OPERATING AS A NEUTRON GENERATOR.

Roche, M. (to Commissariat a l'Energie Atomique). French Patent 2,106,805. 5 May 1972. Filed 24 Sep 1970. (In French).

Improvements to the rotating target of an electrostatic accelerator and to the system for dissipating the power generated in the target are described. (France)

7999 DEVICE FOR CORRECTING AND CENTERING THE BEAM OF AN INDUSTRIAL OR MEDICAL ELECTRON ACCELERATOR. (to CSF-Compagnie Generale de Telegraphie Sans Fil). French Patent 1,603,178. 30 Apr 1971. Filed 31 Jul 1968. (In French).

Electron beams have numerous applications in industry and medicine. In certain cases, the angle of incidence of the useful radiation or beam with the part of the object or patient's body being examined must be easily adjustable and the radiography or radiotherapy machine must be able to rotate about this part. During this rotation the beam is subject to parasitic magnetic fields which vary in magnitude and sign. It is therefore necessary to complete the fixed adjustments with variable adjustments dependent upon the position of the moving part of the machine. A device which compensates for the effect of all such magnetic disturbances affecting the electron beam is presented. (France)

8000 METHOD FOR THE DETERMINATION OF ABSOLUTE PHOTON SPECTRUM OF BREMSSTRAHLUNG. Kusuhara, M. (Tokyo Inst. of Tech.). Nucl. Instrum. Methods; 105: No. 2, 211-13(1972).

A simple method is described for determining absolute photon distribution of bremsstrahlung for the maximum energy $\lesssim$100 MeV. This method is applicable to any thickness of betatron target. An example of bremsstrahlung spectrum determined by this method is presented. (auth)

8001 DYNAMIC POLARIZATION AND RELAXATION OF PROTONS IN 1,6-HEXANEDIOL AND 1,8-OCTANEDIOL: A FEASIBILITY STUDY FOR A FROZEN SPIN POLARIZED TARGET. Borghini, M.; Niinikoski, T. O.; Udo, F.; Weymuth, P. (CERN, Geneva). Nucl. Instrum. Methods; 105: No. 2, 215-220(1972).

Results are given of an experiment to test 1,6-hexanediol and 1,8-octanediol for their suitability as materials for polarized proton targets. The samples are doped with 15% Cr^{V}-glycol complexes. Polarization results are reported at temperatures between 0.4 K and 1.0 K. Relaxation times in different magnetic fields are measured for hexanediol down to 270 mK, for octanediol down to 54 mK. Conclusions are drawn for the parameters of a frozen spin target. (auth)

8002 PION BEAMS AT LAMPF. Burman, R. L. (Los Alamos Scientific Lab., N. Mex.). pp 4.1-17 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The experimental facilities of the LAMPF (Los Alamos Meson Physics Facility) are briefly described. A survey of the three pion channels is given: the (LEPL) low-energy pion channel, providing $\pi^{\pm}$ beams from 20 MeV to 300 MeV; the P^3 channel, transmitting the highest-energy pions the LAMPF can produce; and EPICS. The LEPL and the P^3 channel are achromatic; EPICS is a dispersive channel with magnetic spectrometers. The channel characteristics and expected beam flux are given. (10 figures) (France)

8003 LOW ENERGY PION BEAM OF THE SACLAY LINAC. Miller, J. (CEN de Saclay, Gif-sur-Yvette, France). pp 4.19-27 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Pions ($\leq$100 MeV) are obtained by photoproduction with a copper target using a 420-MeV incident electron beam. The channel accepts the pions produced at 120°. Diagrams representing the π^{+} and π^{-} spectra measured per microampere electron current for a momentum acceptance of $\pm$2% are presented. The variation of the intensity with the acceptance, the beam profile, the electron contamination, and the maximum intensity available for backward and forward muons are given. (France)

8004 BEAMS AND FACILITIES AT TRIUMF. Warren, J. B. (Univ. of British Columbia, Vancouver). pp 4.29-47 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Protons are obtained from the cyclotron by stripping-off the two electrons of H^{-} ions passing through a thin foil. The energy of the protons can be continuously varied from 150 to 500 MeV by varying the position of the stripping foil. A beam burst of 9 nanoseconds duration is expected to be delivered every 44 nanoseconds in operation. The beam current limitations due to H^{-} dissociation and beam spill are discussed. The cyclotron design features are given and the experimental facilities are described: general layout, meson area and proton area. The beam line of the meson area is shown; the yields and the parameters of the beam are given for various targets. The flexible configuration proposed for the proton area is also shown. (7 figures) (France)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

8005 BELFER GRADUATE SCHOOL OF SCIENCE ANNUAL SCIENCE CONFERENCE PROCEEDINGS. VOLUME 2. SOME RECENT ADVANCES IN THE BASIC SCIENCES. Gelbart, A. (ed.). New York; Marcel Dekker, Inc. (1969). 264p. $10.75.

Separate abstracts were prepared for five of the eleven papers. (W.D.M.)

For abstracts of individual chapters see: 8051, 8230, 8420, 8430, and 8478.

Cosmic Radiation

Refer also to abstracts 8025, 8027–8034, 8036, 8107, 8215, 8243–8247, 8249–8265, 8272–8275, 8317–8321, 8348, and 8364.

8006 (NP-19589) BALLOON LAUNCHING STATION, MILDURA, AUSTRALIA. (Department of Supply, Canberra (Australia)). [Sep 1970]. 27p. Dep. NTIS (U. S. Sales Only).

The Australian Dept. of Supply manages the site on behalf of the USAEC for the purposes of conducting high-altitude sampling flights in accordance with USAEC schedules. When not in USAEC use the facilities are available to other scientific users. Launch area location, launch facilities, flight equipment, payload preparation facilities, electronic facilities, launch opportunities, finance, and insurance are described. (Australia)

8007 COSMIC RAYS NEAR THE CENTER OF THE GALAXY. Ginzburg, V. L; Khazan, Ya. M. (Lebedev Inst. of Physics, Moscow). Astrophys. Lett.; 12: No. 3, 155-8(Nov 1972).

The question of the proton–nuclear component of cosmic rays near the center of the Galaxy is discussed. It follows from γ-ray astronomy data that the cosmic-ray intensity in this region is very likely to exceed considerably the corresponding value near the Earth. This is not only interesting in itself but is one more argument against the hypothesis that the main part of cosmic rays in the Galaxy is of metagalactic origin. (auth)

8008 CHLORINE, BROMINE, IODINE, AND URANIUM IN TEKTITES, OBSIDIANS, AND IMPACT GLASSES. Becker, V. J.; Manuel, O. K. (Univ. of Missouri, Rolla). J. Geophys. Res.; 77: No. 32, 6353-9(10 Nov 1972).

The concentrations of chlorine, bromine, iodine, and uranium were determined in tektites, obsidians, and impact glasses by neutron activation. The average concentrations in parts per million for Cl, Br, I, and U in tektites were 2.8, 0.17, 0.28, and 4.3, respectively; in obsidians, 473, 1.2, 1.0, and 11, respectively; and in impact glasses, 20, 0.26, 1.8, and 1.8, respectively. The low halogen content of tektites implies that their production from crustal material would require severe loss of halogens. The tektites contain less halogens than the impactites, but the abundance patterns of halogens in these two glasses are similar. (auth)

8009 ANGULAR DISTRIBUTION OF HIGH ENERGY MUONS OF COSMIC RAYS. Kuridze, R. V. (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 8, 1784-5(Aug 1972). (In Russian).

The angular distribution of muons with average energies of 200 and 500 GeV was obtained in the zenith angle range of 0 to 65°. An ionization calorimeter equipped with a system of hodoscopes was used at a depth of 130 kg cm^{-2} under the earth. (tr-auth)

8010 12th INTERNATIONAL CONFERENCE ON COSMIC RAYS, HOBART, AUSTRALIA, AUGUST 16–25, 1971. VOLUME 3. Hobart, Australia; International Union of Pure and Applied Physics (1971). 424p. (CONF-710807–(Vol.3)).

Twenty nine papers deal with solar modulation and geophysical effects on cosmic radiation. Fourteen are in abstract form only, and fourteen are given separate abstracts. Sixty papers deal with extensive air showers including experiments on radio emission from air showers. Twenty eight are in abstract form only, and thirty two are given separate abstracts. Fifty papers deal with high energy physics aspects of cosmic radiation (interactions generally above 10^{11} eV). Thirty one of these papers are in abstract form only. The remaining nineteen are given separate abstracts. (Australia)

For abstracts of individual papers see: 8011–8038, 8243–8265, 8272–8276, 8299, 8317–8321, 8348, 8364, and 8406.

8011 CALCULATION OF THE DAILY VARIATION OF COSMIC-RAY CUTOFF RIGIDITIES AT FORT CHURCHILL, CANADA. Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 843-7 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.3).

Using the trajectory-tracing process with a mathematical model of the magnetosphere containing magnetic fields of both internal and external origin, cutoff rigidities were calculated for electrons and protons incident at Fort Churchill, Canada. These calculations were made for the vertical direction and at zenith angles of 60 degrees east and 60 degrees west at each hour of the day. The calculated daytime cutoffs were about 150 MV. Precise values for nighttime cutoffs could not be determined; however, the computations indicated that they were less than 20 MV. The vertical cutoff rigidities had an abrupt transition from night to day, a fairly constant daytime value, and an abrupt change from the daytime to nighttime values. Evaluation of the re-entrant trajectories showed that the cosmic-ray albedo electron flux originates at the same invariant latitude as the guiding center of the particle at the detection point. (auth)

8012 CALCULATION OF COSMIC-RAY TRAJECTORIES FOR PALESTINE, TEXAS, USA: CUTOFF RIGIDITIES AND THE ORIGIN OF THE RE-ENTRANT ALBEDO. Shea, M. A.; Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 848-53 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.3).

Utilizing the trajectory-tracing method with the International Geomagnetic Reference Field, cutoff rigidities at 25 different azimuth and zenith angles for Palestine, Texas, USA, were computed. Additional calculations using a magnetospheric model showed a possible slight lowering of the Stormer cutoff rigidity. Continuation of the trajectory-tracing process below the Stormer cutoff allows an evaluation of the re-entrant albedo showing that the invariant latitude of the guiding center of the trajectory at the albedo origin is the same as the invariant latitude of the guiding center of the particle trajectory at the specified zenith and azimuth angle of the detection point. (auth)

8013 CALCULATION OF THE MAGNITUDE OF THE DAILY VARIATION OF VERTICAL CUTOFF RIGIDITIES AND ASSOCIATED CHANGES IN THE NEUTRON MONITOR RESPONSE FOR SELECTED NORTH AMERICAN NEUTRON MONITORS. Shea, M. A.; Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 854-8 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.3).

Vertical cutoff rigidities were calculated as a function of local time for the Deep River, Durham, Swarthmore, and Dallas neutron monitors in an effort to determine the extent of the cutoff variation throughout the day and the corresponding changes in the neutron monitor response. A daily variation of 0.1 GV was found in the effective vertical cutoff rigidity for Deep River; however, for this station the specific yield function at the cutoff rigidity was so small that associated changes in the neutron monitor response were less than 0.02%, and hence undetectable in the neutron monitor data. Systematic changes were not discernible in the effective vertical cutoff rigidity for Durham, Swarthmore, and Dallas. (auth)

8014 CHANGES IN NEUTRON MONITOR RESPONSE AND VERTICAL CUTOFF RIGIDITIES RESULTING FROM SECULAR VARIATIONS IN THE GEOMAGNETIC FIELD. Shea, M. A. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 859-64 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.3).

Vertical cutoff rigidities appropriate for the years 1955, 1965, 1970, and 1975 were calculated by the trajectory-tracing method for 61 selected neutron monitor locations. Changes up to a maximum of 0.70 GV were calculated for locations in Central and

South America. The relative response of selected neutron monitors in this region to the predicted changes in the vertical cutoff rigidity was obtained by use of the neutron monitor differential response functions. It is predicted that all neutron monitors in this area should observe an increase in counting rate ranging from 0.8 to 2.0% between successive solar minima. (auth)

8015 ANOMALOUS LONGTERM MODULATION OF COSMIC RAYS DURING THE PRESENT SOLAR CYCLE. **Stoker, P. H.; Raubenheimer, B. C.; van der Walt, A. J. (Potchefstroom Univ., S. Afr.). pp 870-5 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

From latitude surveys at a pressure altitude of 30,000 feet (307 g/cm^2) along the geomagnetic meridian from Cape Town the modulation of cosmic rays could be accounted for by a modulation function $-\Delta\eta/P$ for the period from 1964 through to 1966. In August 1969 the modulation with respect to the solar minimum period deviates markedly from this function. The modulation in August 1969 could be accounted for either by a function $-\Delta\eta/P^{1.65}$ or by the function $-\Delta\eta/P$ if the cutoff rigidities along the route of flights were 0.5 Gv less in 1969 than for the solar minimum period, or by function simulating the modulation $-\Delta\eta/P$ and an acceleration equivalent to 0.5 Gv. Groundbased neutron monitors favour the latter explanations. (auth)

8016 NEUTRON FLUX VARIATIONS NEAR THE COSMIC RAY KNEE. **Slade, D. V. (Univ. of Melbourne). pp 876-80 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Latitude distributions of the fast neutron flux were obtained during the recent solar maximum with aircraft instrumented with two cadmium shielded NM-64 type proportional counters. High counting rates enable resolution of the high-frequency fluctuations and anomalous sudden decreases which occur in the vicinity of the otherwise smooth cosmic-ray knee. (auth)

8017 FAST NEUTRON ATTENUATION COEFFICIENT IN THE ATMOSPHERE. **Simpson, N. G.; Slade, D. V. (Univ. of Melbourne). pp 881-6 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Two very large proportional counters were flown on aircraft at altitudes up to 150 g cm^{-2} over locations with vertical cutoff rigidity P_c = 1.9, 3.1, 4.3, and 7.2 GV to measure the flux of fast neutrons. One of the counters was also flown on a balloon up to 60 g cm^{-2} at 4.3 GV. The effective attenuation coefficient for these fast neutrons was compared with that obtained from neutron monitor measurements, after allowance was made for the effect of neutron diffusion near the top of the atmosphere. (auth)

8018 DEPENDENCE OF THE NEUTRON MONITOR ATTENUATION COEFFICIENT ON ATMOSPHERIC DEPTH AND ON GEOMAGNETIC CUTOFF IN 1966 AND IN 1970. **Carmichael, H. (Atomic Energy of Canada Ltd., Ont.); Peterson, R. W. pp 887-92 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Measurements with a mobile overland 3-NM-64 neutron monitor and with an airborne IGY type neutron monitor made at altitudes between sea level and 40,000 feet in 1966 soon after solar minimum and in 1970 near solar maximum, at geomagnetic cutoffs between 0.5 and 13.3 GV, were analyzed to find the rate of attenuation of the counting rate throughout the atmosphere. The maximum attenuation observed near the atmospheric depth of 600 mm Hg is discussed in detail. (auth)

8019 ATTENUATION COEFFICIENTS OF VARIOUS COSMIC RAY COMPONENTS IN THE LOWER ATMOSPHERE. **Raubenheimer, B. C.; Stoker, P. H. (Univ. for C. H. E., Potchefstroom, S. Afr.). pp 893-6 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

During August 1969 intensity measurements were made as a function of both altitude and latitude with a C-130 aircraft. The altitude measurements were made at 4.9 and 8.5 GV, on twelve different pressure levels, covering the region from 200 through to 760 mm Hg. Various counters and configurations were used to obtain more knowledge of several cosmic-ray components in different energy regions. (Australia)

8020 SPECTRA AND ZENITH ANGLE DEPENDENCE OF SLOW MUONS IN HONG KONG. **Chuang, L. S. (Chinese Univ. of Hong Kong); Ng, W. H.; Wada, M. pp 897-902 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

A telescope with two plastic scintillators of dimensions 1 × 1 × 0.05 m^3 was used for the measurement of the intensity of slow muons in Hong Kong where the vertical cutoff rigidity is 16.20 GV. A muon which passes through the upper scintillator and comes to rest in the lower one was identified by the delayed coincidence with its decay electron. The omnidirectional intensity was found to be 0.24 ± .01 g^{-1} day^{-1}. As for the spectra and zenith angle dependence, the situation was somewhat complicated and only preliminary results are given. (auth)

8021 SOLAR MODULATION OF ATMOSPHERIC NEUTRON FLUX, EXPERIMENT AND CALCULATION. **Light, E. S.; Merker, M.; Korff, S. A.; Mendell, R. B. (New York Univ., N. Y.). pp 903-8 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The steady-state distribution of neutrons in the atmosphere was calculated by a Monte Carlo simulation of neutron production and transport. Monoenergetic primary protons and alphas from 20 MeV to 100 GeV per nucleon were assumed. The results were applied to calculate the global neutron distribution from the primary cosmic-ray spectrum under varying degrees of solar modulation. The calculated neutron fluxes from 1 to 10 MeV were compared with balloon and aircraft measurements of the fast neutron flux between 1964 and the present. Features of the observed fast neutron flux, such as spectrum, time variations, and spatial distribution were reproduced within the uncertainties of the input parameters. (auth)

8022 CALCULATION OF THE MULTIPLICITY YIELD FUNCTION OF THE NM-64 NEUTRON MONITOR. **Debrunner, H.; Flueckiger, E. (Univ., Bern). pp 911-16 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Relating the intensity time variations of neutron monitors to the variations of the primary cosmic ray spectrum at the top of the atmosphere, the multiplicity yield function of the NM-64 neutron monitor was determined for multiplicities $1 \leq m \leq 20$, at the atmospheric depths h = 650 g cm^{-2} and 1033 g cm^{-2}, and for vertically incident primary cosmic-ray protons of the rigidity range 2.2 GV $\leq R_0 \leq$ 100 GV. Furthermore, the differential response functions for the various multiplicities and for the total counting rate were computed. Comparisons show that the theoretical results are in good agreement with corresponding experimental data. (auth)

8023 STAR PRODUCING NUCLEONS IN THE STRATOSPHERE. **Simpson, N. G.; Hopper, V. D. (Univ. of Melbourne). pp 917-22 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 3).

The altitude variation of the star production rate was measured from several balloon flights to level altitudes between 3 and 80 g cm^{-2} at 47 and 43°S, and was compared with calculated values. The measured ratio of the neutron to proton fluxes was also compared with theory. An estimate was made of the proton and neutron spectra corresponding to an average atmospheric depth of 25 g cm^{-2}. (auth)

8024 DIRECTIONAL DEPENDENCE OF SEA LEVEL MUON COUPLING COEFFICIENTS. **Cooke, D. J.; Fenton, A. G. (Univ. Tasmania, Hobart, Australia). pp 923-8 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The form of the low-momentum muon coupling coefficients over a range of zenith angles was deduced from latitude survey data. The analysis technique adopted obviates the necessity for making detailed corrections to the data for removal of dependence on the latitude variation of atmospheric conditions. Extrapolation of the coefficients to high momenta and high zenith angles has been effected, and the coupling coefficients expressed in terms of continuous functions of zenith angle and momentum. The dependence of the coupling coefficients on azimuth is discussed. (auth)

8025 CHEMICAL COMPOSITION OF COSMIC RADIATION AT ENERGIES OF 3×10^{15} TO 10^{16} eV. **Samorski, M.; Staubert, R.; Truemper, J.; Boehm, E. (Univ., Kiel). pp 959-64 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The Δ/N-distribution (Δ central density, N shower size) was determined for shower sizes between 3×10^5 and 10^6, where detection fluctuations and influences of triggering conditions can be shown to be small. A comparison of the Δ/N-distribution with results of various Monte Carlo calculations indicates that the chemical composition at the corresponding energies cannot be much different from a pure proton or mixed composition. (Australia)

8026 POSSIBILITY OF A SIGNIFICANT FLUX OF PRIMARY γ-RAYS ABOVE 10^{18} eV. **Wdowczyk, J. (Inst. of Nuclear Research, Lodz, Poland); Tkaczyk, W.; Adcock, C.; Wolfendale, A. W. pp 965-9 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

If the cosmic rays above 10^{18} eV are of extragalactic origin and if the 2.7°K blackbody radiation is truly universal then a significant flux of primary γ rays may result from their interaction. Calculations have been made of the expected flux allowing for cascading of the γ rays by way of $\gamma-\gamma$ interactions and inverse Compton effect interactions of the resulting electrons. Approximate calculations indicate a $\gamma-p$ ratio of 3 to 4% at 10^{19} eV. (auth)

8027 ENERGY SPECTRUM OF LARGE AIR SHOWERS. **Andrews, D.; Edge, D. M.; Evans, A. C.; (and others) (Univ. of Leeds, Eng.). pp 995-1000 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The primary energy spectrum in the range 3.10^{17} eV $\leq E_p \leq 10^{19}$ eV is measured to be: $I(>E_p) = (4.5 \pm 0.2) \times 10^{-10} [(E_p/10^{17})]^{-2.24 \pm 0.04}$ m^{-2} s^{-1} sr^{-1}. There is no evidence for any change of slope in this energy range. (Australia)

8028 MEASUREMENT OF PRIMARY ENERGY OF AIR SHOWERS IN THE PRESENCE OF FLUCTUATIONS. **Hillas, A. M.; Marsden, D. J.; Hollows, J. D.; Hunter, H. W. (Univ. of Leeds, Eng.). pp 1001-6 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Model calculations show that fluctuations in the particle density at axial distances of several hundred meters are much less than those occurring at smaller distances, and as there is a characteristic distance ~500m at which density is well determined by a large detector array, fluctuations should play a very small part in the selection of showers by arrays such as that at Haverah Park. The slope of the Volcano Ranch energy spectrum is discussed in the light of this characteristic distance. (Australia)

8029 CONNECTION BETWEEN LONGITUDINAL FLUCTUATIONS IN SHOWER DEVELOPMENT AND PARTICLE ARRIVAL TIMES AND DENSITIES AT LARGE AXIAL DISTANCES. **Marsden, D. J.; Hillas, A. M.; Hollows, J. D.; Hunter, H. W. (Univ. of Leeds, Eng.). pp 1013-18 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The magnitude of fluctuations in the pulse shapes to be expected in a 1.2m deep water Cherenkov detector at axial distances >400m arising from fluctuations in the points of interaction of the leading nucleon in a proton-initiated shower is discussed, as this may provide a possible method for investigating primary mass. Fluctuations in the longitudinal development of shower size and the lateral distribution of particle density are also discussed. (Australia)

8030 CHANGE IN THE EAS AGE PARAMETER s AS A FUNCTION OF THE CONTENT OF THE PENETRATING COMPONENT. **Catz, Ph.; Hochart, J. P.; Maze, R.; Zawadzki, A. (Laboratoire de Physique Cosmique, Verrieres le Buisson, France). pp 1035-7 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

It was established experimentally that the value of the s parameter (frequently known as the age parameter of a shower) increases systematically with the content of the penetrating component in a shower of constant average size. The result was represented quantitatively. Its value lies in the possibility of applying it to the elaboration of an EAS development model. (Australia)

8031 MECHANISM OF EAS RADIO EMISSION. **Allan, H. R. (Imperial Coll. of Science and Tech., London); Jones, J. K.; Mandolesi, N.; Prah, J. H.; Shutie, P. pp 1097-1101 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The polarization of the radio pulses emitted by extensive air showers of energy 10^{17} to 10^{18} eV was studied with a radio receiving system very similar to that described in earlier publications (Allan et al., 1969, 1970). Six radio receiving channels were operated simultaneously, two each at 32 MHz, 60 MHz and 105 MHz, with corresponding bandwidths 3.6 MHz, 4.5 MHz, and 3.6 MHz. The antennas are located at a single site 80 m from the center of the Haverah Park 500 m array. They are aligned to pick up the two horizontal components of the radiation in the geomagnetic N-S and E-W directions at each frequency. For both orientations the theoretical polar diagram of the reception sensitivity consists of a single lobe with its maximum towards the zenith and a null towards the horizon. The receiver outputs are passed through delay cables to linear detectors and separate oscilloscope displays. When the particle array detects a shower the outputs of the receivers are photographed on a 5 μs duration timebase. A time marker gives the location of the position on each time base corresponding to the time of arrival of the shower particles at the antenna. The matching, voltage gain, and bandwidth of each radio channel have been accurately determined. The best estimate of the variation of antenna sensitivity with zenith and azimuthal angle was taken to be the theoretical value, with an expected error of less than 10% over the angular range used in the experiment. Calibration of the voltage gain of the equipment was carried out every four weeks and showed a typical fluctuation of gain of 10%, primarily due to the change of preamplifier gain with temperature. The showers accepted for full analysis all had zenith angles less than 36°, to ensure that both the particle and radio parameters were determined with maximum precision. (Australia)

8032 DEPENDENCE OF RADIO PULSE AMPLITUDE ON FREQUENCY AND ON AIR SHOWER PARTICLE PARAMETERS. **Allan, H. R. (Imperial Coll. of Science and Tech., London); Jones, J. K.; Mandolesi, N.; Prah, J. H.; Shutie, P. pp 1102-7 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).**

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The experimental procedures described in an accompanying work yield measurements of the radio pulse amplitude from an air shower at the three frequencies 32, 60 and 105 MHz, at a single aerial site on the Haverah Park array. As described the observed field strengths per unit bandwidth ϵ_ν are normalized to showers of standard primary energy and fixed angle with respect to the earth's magnetic field lines. The normalized field strengths ϵ_ν^N refer to showers of primary energy $E_p = 10^{17}$ eV moving at right angles to the earth's field. The way ϵ_ν^N depends upon frequency, shower zenith angle θ, distance from the shower axis R, and the distribution of the shower particles with height (the longitudinal development) is briefly discussed. (Australia)

8033 LATERAL DISTRIBUTION OF THE RADIO EMISSION AND ITS DEPENDENCE ON THE LONGITUDINAL STRUCTURE

OF THE AIR SHOWER. Allan, H. R. (Imperial Coll. of Science and Tech., London). pp 1108-12 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The lateral distribution of the radio emission from an air shower is calculated by the methods developed previously. It is found that the width of the distribution is strongly influenced by the height of the shower maximum, whereas the transverse distribution of particles across the shower disc is only of secondary importance. When the shower maximum is high in the atmosphere the distribution is broader and has a minimum on the shower axis. (Australia)

8034 RADIO EMISSION AND THE STRUCTURE OF THE SHOWER DISC. Allan, H. R. (Imperial Coll. of Science and Tech., London). pp 1113-18 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

In its passage through the atmosphere, an extensive air shower leaves behind a static electric dipole moment as a result of the geomagnetic separation of charge. Viewed from a radio receiving antenna, this dipole moment rises to its final value at a rate determined by the spatial distribution of the shower particles behind the shower front, i.e., the disc thickness. From the total dipole moment and its apparent rate of growth an estimate is obtained of the radiated electric field strength. (Australia)

8035 DESIGN OF EXTENSIVE RADIO ARRAYS FOR THE DETECTION OF LARGE AIR SHOWERS. Spencer, R. E. (Univ. of Manchester, Jodrell Bank, Eng.). pp 1119-22 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Any method of detecting large air showers by radio means alone must distinguish between radio impulses from showers and impulses from other natural causes and from man-made interference. This paper describes the properties of the radio emission from air showers, comparing them with the properties of impulses from likely sources of interference. Experimental measurements have been made of the radio noise environment at a quiet site. The design requirements of a radio array are given which result from experience gained in these measurements. (auth)

8036 OBSERVATION OF RADIO PULSES AT THREE FREQUENCIES WITH THE SAME ANTENNA. Hazen, W. E.; Hendel, A. Z.; Smith, H.; Castle, R. J. (Univ. of Michigan, Ann Arbor). pp 1125-6 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The signal from a single log-periodic antenna followed by a wide-band amplifier was fed into three narrow-band ($3\frac{1}{2}$ MHz) channels centered on 57, 85 and 177 MHz. For some showers, pulses were observed in all three channels. The pulse heights at 87 MHz were about one-half of those at 57 MHz and the pulse heights at 177 MHz were about one-third of those at 57 MHz. The first of these ratios was smaller at greater distances from the shower core. (Australia)

8037 PROTON AND PION MOMENTUM SPECTRA AT SEA LEVEL IN THE RANGE 1 TO 30 GeV/c. Diggory, I. S.; Dixon, H. E.; Earnshaw, J. C.; (and others) (Durham Univ., Eng.). pp 1236-40 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The momentum spectra of protons and pions in the cosmic-ray beam at sea level were measured using a device comprising an air gap magnet spectrograph and a modified IGY neutron monitor. The technique followed closely that evolved by Brooke and Wolfendale (1964) but the experiment incorporated improvements and the data were improved in statistics over those previously available. The spectra were found to be in a substantial agreement with the earlier measurements. (auth)

8038 COMPARISON OF THE ENERGY RESPONSE OF AN IONIZATION SPECTROMETER FOR PIONS AND PROTONS. Jones, W. V.; Verma, S. D. (Louisiana State Univ., Baton Rouge). pp 1242-6 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

An ionization spectrometer consisting of a sandwich of iron absorbers and plastic scintillation counters was used to measure the energy of pions and protons in the interval 10-1000 GeV. For the limited energy interval of 10 to 40 GeV, pions and protons were identified by an air Cherenkov counter. Interactions in carbon were studied in a multiplate cloud chamber placed between the Cherenkov counter and the spectrometer. Knowledge of these interactions has been used in conjunction with a Monte Carlo simulation of the cascade process to study differences in the response of the spectrometer to pions and protons. (auth)

8039 NONPLANAR RELATIVISTIC FLOW. Eltgroth, P. G. (Univ. of California, Livermore). Phys. Fluids; 15: No. 12, 2140-4(Dec 1972).

The equations for nonplanar relativistic flow are solved by similarity analysis for a restricted set of problems. The relativistic equation of state $p = \frac{1}{3} E$ is used. The solutions obtained are for flow resulting from a point source of energy at the origin, having a power law time dependence. The results are applied to the problem of spherical shock propagation into a medium and to the problem of cosmic-ray generation from supernovae. It is found that the predicted spectrum of cosmic rays is somewhat steeper than is actually observed. (auth)

8040 MODULATION OF LOW-ENERGY GALACTIC COSMIC RAYS OVER SOLAR MAXIMUM (CYCLE 20). Van Hollebeke, M. A. I.; Wang, J. R.; McDonald, F. B. (Goddard Space Flight Center, Greenbelt, MD). J. Geophys. Res.; 77: No. 34, 6881-5(1 Dec 1972).

Observations of low-energy (~60 MeV/nucleon) galactic cosmic rays were made during the recent period of solar maximum. During this cycle 20, a significant time lag between intensity changes in the low-energy and high-energy components was observed. Simple explanations of this hysteresis effect include that either changes in the form of the magnetic-field power spectrum or changes in the size of the effective modulating region or both exist. The time histories of the 60-MeV/nucleon galactic protons and α particles and of the high-energy component are shown from the Deep River neutron monitor rates for the period June 1967 to Oct. 1971. Low-energy data were obtained from the Goddard Space Flight Center cosmic-ray experiments flown on IMP 4 and 5. It is shown that the low-energy components and the neutron monitor rates display the same trends from 1967 to mid-1970. By early 1971, the Deep River neutron monitor rate had returned to its 1967 level, whereas the 60-MeV/nucleon proton and α particle intensities had just begun to show significant increases. Results show that there is a well-defined hysteresis in solar cycle 20 and that this effect is strongly rigidity dependent. A study is then made of whether the phenomena of cycle 20 are characteristic of other solar cycles. (24 references) (J.C.W.)

8041 COULOMB–BORN–OPPENHEIMER CROSS-SECTIONS FOR EXCITATION OF HYDROGENIC IONS OF INFINITE Z BY ELECTRON IMPACT. Parks, A. D.; Sampson, S. H. (Pennsylvania State Univ., University Park). Astrophys. J.; 178: No. 2, 571-5(1 Dec 1972).

Coulomb–Born–Oppenheimer cross-section calculations were made for all the $2l \rightarrow 3l'$ and $1s \rightarrow 3l'$ transitions for hydrogenic ions with $Z = \infty$. The calculations were made for impact electron energies of 1 and 1.5 in threshold units. On the basis of the results some slight modifications of previous semiempirical cross-section formulae are suggested. (auth)

8042 NUCLEAR GAMMA RAYS FROM ^{7}Li IN THE GALACTIC COSMIC RADIATION. Fishman, G. J. (Teledyne Brown Engineering, Hunstville, AL); Clayton, D. D. Astrophys. J.; 178: No. 2, 337-40(1 Dec 1972).

The observation of a γ-ray line feature from the direction of the galactic center by Johnson, Harnden, and Haymes is interpreted as the 478-keV nuclear de-excitation of low-energy ^{7}Li cosmic rays as they inelastically scatter from the interstellar gas. The prediction of an associated line at 432 keV is proposed as a definitive test of this idea. (auth)

8043 ANGULAR DISTRIBUTION OF WIDE ATMOSPHERIC SHOWERS AT LARGE ZENITH ANGLES. Vdovchik, Yu.; Gavin, Yu.; Katts, F.; Maz, R.; Oshar, Zh. P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 8, 1721-5(Aug 1972). (In Russian).

The properties of extensive atmospheric showers arriving at angles >60° were studied at two different locations with detecting

equipment capable of measuring electron densities, the density of penetrating components, and for analyzing the delay and determining the angles of shower arrival. Angular distributions of the showers, and the ratios of penetrating component density/total density were studied. The existence of anomalous atmospheric showers is discussed. (K.S.W.)

Stars

Refer also to abstracts 8094, 8141, and 8158.

8044 DEPLETION OF LOW-MASS STARS IN CLUSTERS. Aarseth, S. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.); Woolf, N. J. Astrophys. Lett.; 12: No. 3, 159-64(Nov 1972).

Analysis of the luminosity function of Hyades members indicates that the population of faint stars falls below the field star distribution by at most a factor of four in the range $M_V = +5$ to $+15$ mag. The hypothesis of dynamical depletion is tested by numerical integrations of N-body systems which include tidal effects and supernova events. Calculated cluster models containing 250 members show no preferential evaporation of light particles on time-scales comparable to the half-life. Most supernova remnants do not escape until about 80% of the initial members are lost. (auth)

8045 ELECTRON SCATTERING IN SPHERICALLY EXPANDING ENVELOPES. Auer, L. H. (Yale Univ., New Haven); Van Blerkom, D. Astrophys. J.; 178: No. 1, 175-81(15 Nov 1972).

Broad emission-line profiles from diverse astronomical objects have been interpreted as due to rapid radial outflows of matter. Estimates of characteristic electron densities lead to the conclusion that the effect of electron scattering on the line profiles may be substantial. A Monte Carlo method is employed to treat the transfer of radiation through an expanding envelope of comoving electrons and ions. Two models are considered: one with a constant velocity of outflow, and one in which the velocity increases linearly with radius. A spectral line is formed by recombination, and the only opacity is that due to free electrons. For electron-scattering optical depths of order unity, very extensive wings to the red of line center are formed in all cases. These results are applied to models of Wolf–Rayet stars and Seyfert galaxies. (auth)

8046 THERMAL PULSES IN HELIUM SHELL-BURNING STARS. Faulkner, D. J.; Wood, P. R. (Australian National Univ., Canberra). Astrophys. J.; 178: No. 1, 207-19(15 Nov 1972).

The helium shell-burning evolution of a 0.8 $M_\odot$ star was calculated with a detailed treatment of the abundance profile in the shell source. Contrary to a suggestion by Paczyński that pure helium stars are thermally stable when so treated, the star undergoes a single thermal pulse before entering the white-dwarf region at the end of its evolution. Since Kutter has found a 1.04 $M_\odot$ star to be stable, ~0.8 $M_\odot$ appears to be the upper mass limit for the thermal instability phenomenon in pure helium stars. The decay time of the thermal pulse is in good agreement with the observed rate of evolution for the nuclei of planetary nebulae, and it is suggested that planetary-nebula shells may be ejected by radiation pressure during such a pulse. The calculations show that further pulse events are possible even if the shell ejection removes all hydrogen-rich material. The present pulse was not sufficiently luminous, however, to eject any helium-rich material. (auth)

8047 UBV PHOTOMETRY OF SOME SELECTED STARS IN THE HYADES. Pesch, Peter (Warner and Swasey Observatory, Cleveland). Astrophys. J.; 178: No. 1, 203-6(15 Nov 1972).

Consideration of both new and existing photoelectric UBV photometry shows that systematic errors in earlier color indices are responsible for most of the points which, in a color–magnitude diagram of the Hyades cluster, fall between the main sequence and the white-dwarf sequence. The light curve of a flare of a Hyades member not previously known to be a flare star is presented. (auth)

8048 ULTRAVIOLET PHOTOMETRY FROM THE ORBITING ASTRONOMICAL OBSERVATORY. V. THE HELIUM-WEAK STARS. Bernacca, P. L. (Goddard Space Flight Center, Greenbelt, MD); Molnar, M. R. Astrophys. J.; 178: No. 1, 189-201 (15 Nov 1972).

Ultraviolet filter photometry with the Wisconsin Experiment Package aboard OAO-2 was carried out for the helium-weak stars 3 Cen A, 3 Sco, HD 144334, HD 21699, HD 144844, α Scl, HR 8535, HR 8770, and HD 144661. The flux distribution was compared with that of B3 to B8 main-sequence and giant stars in terms of color–color diagrams. After taking into consideration line blocking shortward of 2800 Å due to lines of P II, Ga II, Si II, Si III, Ti II, and Sr II, it was found that most of the helium-weak stars have normal fluxes in good agreement with their ground-based colors. However, it is difficult to consider HR 8535, HR 8770, and HD 144661 as having normal flux distributions and they may be brighter than normal at 3320 Å. The star, α Scl, is a photometric variable. It is suggested that variations in the strengths of lines of Ti II, Cr II, and Sr II around 2400 Å are responsible for this phenomenon, causing a redistribution of flux between the far-ultraviolet and visual regions. The flux distribution indicates an effective temperature about 1500°K higher than previously determined. (auth)

8049 VERY-LOW-EXCITATION COMPACT NEBULAE. Sanduleak, N.; Stephenson, C. B. (Warner and Swasey Observatory, Cleveland). Astrophys. J.; 178: No. 1, 183-7(15 Nov 1972).

A finding list is given for 23 emission-line objects which show an extremely-low-excitation nebular component in their spectra. Some of these may be planetary nebulae in an early stage of development. Such objects are rare, comprising only about five percent of the planetary-like nebulae detected in an objective-prism survey of the southern Milky Way. (auth)

8050 STELLAR ROTATION. Proceedings of the IAU Colloquium Held at Columbus, Ohio, September 8–11, 1969. Slettebak, A. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970). 367p. (CONF-690991).

The proceedings are a collection of six review papers and 33 contributed papers, plus the discussion following the papers, on problems of stellar and solar rotation. The colloquium was organized along the following lines: effects of rotation on stellar interiors and evolution; effects of rotation on stellar atmospheres; stellar rotation in clusters, binaries, and special objects; and the rotation of the Sun. (W.D.M.)

8051 NEUTRINOS AND STELLAR EVOLUTION. Salpeter, E. E. (Cornell Univ., Ithaca, NY). pp 105-19 of Belfer Graduate School of Science Annual Science Conference Proceedings. Vol. 2. /Gelbart, A. (ed.). New York; Marcel Dekker, Inc. (1969).

A brief review of stellar evolution is followed by discussions on hydrogen burning, neutrino pair production, and highly evolved stars. (W.D.M.)

8052 LIFETIMES OF EXCITED STATES IN Mg I, Cd I, AND Mg II. Andersen, T.; Moelhave, L.; Soerensen, G. (Univ. of Aarhus, Denmark). Astrophys. J.; 178: No. 2, 577-82(1 Dec 1972).

The beam-foil technique was used to measure mean lives of some excited states in Mg I, Cd I, and Mg II. The reported Mg I and Cd I lifetimes were considerably shorter than the mean lives recently reported by Schaefer, using the delayed-coincidence technique. (auth)

8053 OBSERVATIONS OF SHIFTS OF HYDROGEN LINES. Bengtson, R. D.; Chester, G. R. (Univ. of Texas, Austin). Astrophys. J.; 178: No. 2, 565-9(1 Dec 1972).

Laboratory measurements of the profiles of Stark-broadened lines emitted from a radiofrequency-generated plasma ($n_e \approx 1.2 \times 10^{13}$ cm^{-3}) show small redshifts for lines arising from odd upper levels ($N_{upper} = 13, 15, 17$). No shift is noted for the even lines. No asymmetries could be found within experimental error. Shifts of odd Balmer lines were also observed in the spectrum of Sirius. (auth)

8054 ULTRAVIOLET STELLAR FLUXES. II. IMPORTANCE OF CO BAND ABSORPTION AND BOUND-FREE ABSORPTION OF Al I IN A, F, G, AND K STARS. Tarafdar, S. P.; Vardya, M. S. (Inst. of Fundamental Research, Bombay). Astrophys. J.; 178: No. 2, 503-7(1 Dec 1972).

The discrepancy between observed and calculated ultraviolet fluxes of A to G stars can be largely alleviated between λλ1376 to 2400 Å, if absorption coefficients of the A–X band of CO and bound-free transitions of Al I are incorporated in the model calculations. However, the discrepancy around λ2800 needs further investigation. (auth)

8055 ULTRAVIOLET PHOTOMETRY FROM THE ORBITING ASTRONOMICAL OBSERVATORY. VI. MAGNESIUM II 2800 A EMISSION IN COOL STARS. Doherty, L. R. (Univ. of Wisconsin, Madison). Astrophys. J.; 178: No. 2, 495-501 (1 Dec 1972).

Spectral scans of the 2800 Å region made with 25 Å resolution are presented for 19 giants and supergiants of spectral types G, K, and M. Mg II emission fluxes are given for eight of these stars and compared with the emission in Ca II K. (auth)

8056 NEWLY DISCOVERED VARIABLE: THE Ap STAR HR 5153. Burke, E. W. Jr.; Howard, J. T. (King Coll., Bristol, TN). Astrophys. J.; 178: No. 2, 491-3(1 Dec 1972).

The Ap star HR 5153 was discovered to be a periodic variable. The mean amplitude (maximum to minimum) is 0.056 mag in B and 0.052 mag in U, but there appears to be no variation in V. The ephemeris for minimum light in B is JD (hel.) = 2440753.713 + 1.706E ± 0.001d. (auth)

8057 TITANIUM ISOTOPES IN OMICRON CETI. Wyckoff, Susan; Wehinger, Peter (Univ. of Kansas, Lawrence). Astrophys. J.; 178: No. 2, 481-9(1 Dec 1972).

Profiles of the TiO γ_3 0–0 band (7054 Å) were computed for a variety of assumed fractional abundances of the five stable titanium isotopes. From a comparison of the computed spectra and an observed spectrum of the long-period variable o Ceti (M6e) at maximum light, the following limits for the isotopic abundance ratios were determined: $^{46}Ti/^{48}Ti < 0.18 \pm 0.05$, $^{47}Ti/^{48}Ti < 0.18 \pm 0.05$, $^{49}Ti/^{48}Ti < 0.18 \pm 0.05$, and $^{50}Ti/^{48}Ti < 0.27 \pm 0.05$. An apparent enhancement of ^{50}Ti over the other less abundant titanium isotopes may be attributable to the s-process. Evidence for the presence of ^{18}O could not definitely be established. (auth)

8058 BALMER PROGRESSION DURING PLEIONE'S SHELL EPISODE, 1938–1954. Marlborough, J. M.; Gredley, P. R. (Univ. of Western Ont., London). Astrophys. J.; 178: No. 2, 477-80(1 Dec 1972).

The hypothesis that the Balmer progression during Pleione's shell phase is due to different effects of reemission in the Balmer lines was investigated numerically. It is shown that inclusion of reemission in the Balmer lines for the specific model due to Limber of Pleione's circumstellar shell does not account for the Balmer progression as it was observed. (auth)

8059 DYNAMICS OF M STARS IN THE SOUTHERN GALACTIC CAP. Jones, D. H. P. (Australian National Univ., Canberra). Astrophys. J.; 178: No. 2, 467-76(1 Dec 1972).

The radial velocities of HD M stars in the southern galactic cap were measured with a photoelectric speedometer. Their velocity dispersion is 7 km s^{-1} in the plane, rises to 28 km s^{-1}, and thereafter remains steady. Using conventional dynamical theory, the density variation of these stars with distance below the plane implies a density of gravitating matter of 0.21 $M_\odot$ pc^{-3} in the solar neighborhood. This is not significantly higher than the values obtained by similar methods for other groups of stars. The distribution of total energies of motion perpendicular to the plane accords with the collapse picture of the Galaxy. (auth)

8060 LOCATION OF PULSATIONAL BLUE EDGES AND ESTIMATES OF THE LUMINOSITY AND HELIUM CONTENT OF RR LYRAE STARS. Tuggle, R. S. (Massachusetts Inst. of Tech.; Cambridge); Iben, Icko Jr. Astrophys. J.; 178: No. 2, 455-65(1 Dec 1972).

Blue edges of the instability region for pulsation in the fundamental and first harmonic modes were constructed with Cox–Stewart opacities treated by spline interpolation. In the region relevant for an estimate of the bulk properties of RR Lyrae stars, first-harmonic blue edges are bluer by approximately $\Delta \log T_e \sim 0.03$ than those obtained by using Christy's analytic approximation to Cox–Stewart opacities. As a consequence, estimates of the helium abundance in the envelopes of RR Lyrae stars are reduced by $\Delta Y \sim 0.06$. (auth)

8061 COMMENTS ON A PLC RELATIONSHIP FOR CEPHEIDS AND ON THE COMPARISON BETWEEN PULSATION AND EVOLUTION MASSES FOR CEPHEIDS. Iben, Icko Jr. (Univ. of Colorado, Boulder); Tuggle, R. S. Astrophys. J.; 178: No. 2, 441-53(1 Dec 1972).

It is suggested that a period–luminosity–color (PLC) relationship currently in use for Cepheids in the Galaxy is not a unique summary of the observational facts and may, in fact, be inconsistent with elementary pulsation theory. Consequently, when this PLC relationship is used to estimate Cepheid luminosities and these luminosities are in turn used to estimate Cepheid masses, one obtains a mass-luminosity relationship whose slope may be far from the truth. Alternate PLC relationships that are consistent both with the observational facts and with pulsation theory are presented. It is suggested that either (1) the original estimates of luminosity (on which the normalization of the standard PLC relationship is based) be used to establish a mass–luminosity relationship for galactic Cepheids or (2) the slope of the mass–luminosity relationship given by evolutionary calculations be accepted and be used to estimate relative luminosities. The effect on blue edges of using spline interpolation in new Cox–Stewart opacities is shown for a single mass. It is suggested that, in estimating the pulsation mode and mass of any Cepheid, the location of that Cepheid in the H–R diagram relative to blue edges for pulsation in the fundamental and first harmonic modes be taken into account. (auth)

8062 CEPHEIDS: PRESUPERNOVAE, AND THE $^{12}C(\alpha,\gamma)^{16}O$ REACTION. Iben, Icko Jr. (Univ. of Colorado, Boulder). Astrophys. J.; 178: No. 2, 433-40(1 Dec. 1972).

Models of mass 5, 7, and 9 $M_\odot$ were carried through core helium burning with several choices for the reduced width θ_α^2 of the 7.12-MeV level in ^{16}O. Comparison with classical Cepheids in the Galaxy suggests that consistency is possible for $0.08 < \theta_\alpha^2 < 0.25$. Models of mass 7 $M_\odot$ were carried further into the shell helium-burning and shell hydrogen-burning stage with the objective of determining whether or not carbon ignition and detonation can be initiated off-center, the expected result being a condensed remnant and the liberation of energy comparable to that attributed to supernova explosions. Also discussed are changes in envelope and surface abundances of the elements H, He, C, N, and O. These changes occur during two separate red giant stages. At the surface of the 7 $M_\odot$ presupernova model, the number ratios He/H and O/C are each 40% larger than at the surface of a main-sequence precursor. (auth)

8063 ROTATION AND THE OCCURRENCE OF CARBON DETONATION IN PRESUPERNOVA MODELS OF INTERMEDIATE MASSES. Sackmann, I. J.; Weidemann, Volker (California Inst. of Tech., Pasadena). Astrophys. J.; 178: No. 2, 427-31 (1 Dec 1972).

Degenerate C/O cores of stars between 3.5 and 7 $M_\odot$ evolve qualitatively different if they retain a considerable fraction of their original main-sequence angular momentum J. Carbon detonation either is prevented or, with smaller J, will occur at core masses above the Chandrasekhar limit. The correspondingly increasing luminosity will terminate this phase of evolution by mass loss. (auth)

8064 STAR DISTRIBUTION NEAR A COLLAPSED OBJECT. Peebles, J. J. E. (Princeton Univ., NJ). Astrophys. J.; 178: No. 2, 371-5(1 Dec 1972).

A derivation is given of the steady-state distribution of stars near a massive collapsed object (such as a black hole) in a star cluster. (auth)

8065 STELLAR EVOLUTION IN ELLIPTICAL GALAXIES. Tinsley, B. M. (Univ. of Texas, Dallas). Astrophys. J.; 178: No. 2, 319-36(1 Dec 1972).

Elliptical galaxies are described by models in which the evolution of stars is followed for 12 billion years. Stellar birthrates chosen are mainly power laws in stellar mass, cut off after 10^9 years; effects of these oversimplifications are discussed. Integrated magnitudes, broad-band colors, narrow-band scanner spectral energy distributions, and strengths of spectral features are derived as a function of time. Comparison of computed with empirical energy distributions sets limits to the galactic age for each initial mass function (IMF). Unless the Universe is extremely young, a fairly shallow IMF is required. There are then few late dwarfs to provide unchanging light, so significant evolution toward fainter luminosities must occur. The magnitude–redshift relation is affected in such a way that q_0 appears larger than its true value by at least 0.5. The colors of models with a shallow IMF evolve very slowly, however, because much of their light comes from low-mass giants whose colors depend very weakly on mass; this result agrees with colors of galaxies observed at large redshifts. The possibility of continued star formation in the nuclei of some ellipticals, from gas shed by stars dying throughout the galaxy, can explain the occurrence of Balmer absorption lines and emission lines from H II regions. Production of metals during the first 10^9 years is calculated, leading to an explanation of the observed increase in stellar metal abundance and redness toward the center. The computed abundances are lower than observed, however. If a preceding short burst of very massive stars has occurred, these can produce enough metals, leave invisible stellar remnants to provide the observed high mass-to-light ratios, and radiatively ionize the intergalactic medium at the epoch of galaxy formation. (auth)

8066 COUPLING OF GRAINS TO THE GAS IN CIRCUMSTELLAR ENVELOPES. Gilman, R. C. (Univ. of Minnesota, Minneapolis). Astrophys. J.; 178: No. 2, 423-6(1 Dec 1972).

Dust grains in circumstellar envelopes are not position coupled to the gas, but they are momentum coupled; therefore, radiation pressure on the grains can drive the mass loss. (auth)

8067 NEW CROSS-SECTIONS FOR s-PROCESS NUCLEOSYNTHESIS. Stroud, D. B. (Melbourne Univ., Parkville, Australia). Astrophys. J.; 178: No. 2, L93-4(1 Dec 1972).

The 30-keV neutron-capture cross sections of the separated isotopes ^{94}Mo, ^{96}Mo, ^{110}Cd, and ^{136}Ba were measured. The result for ^{136}Ba verified the existence of a plateau at A = 138 in the $N_s\sigma$ versus A diagram, and the measurement on ^{96}Mo and ^{110}Cd suggested certain anomalies between the present data and theoretical fit. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 8152.

8068 (CSIRO-Trans-11078) ON THE DIFFUSION OF RELATIVISTIC ELECTRONS FROM DISCRETE RADIO SOURCES. Vaisberg, V. V. Translated by G. Losonci (Commonwealth Scientific and Industrial Research Organization), from Astron. Tsirk.; No. 526, 3-5(1969). 4p. Dep. NTIS (U. S. Sales Only).

A calculation is derived for the fraction of electrons remaining in a nebula with a specified mean free path. Some values are tabulated. It is possible to establish the spectrum of electrons remaining in the source from the table. (Australia)

8069 X-RAY ABSORPTION MEASURE OF Sco X-1. Bunner, A. N.; Coleman, P. L.; Kraushaar, W. L.; McCammon, D. (Univ. of Wisconsin, Madison). Astrophys. Lett.; 12: No. 3, 165-8(Nov 1972).

A soft x-ray spectrum of Sco X-1 was recorded by a rocket-borne proportional-counter payload flown in May 1970. No x rays were detected below 0.28 keV. The observed pulse-height distribution is compared with predictions based on various source-function models. A simple exponential (free–free) source spectrum provides a good fit, requiring a gas column density of 22 to 40×10^{20} hydrogen atoms cm^{-2} along the line of sight. (auth)

8070 POSSIBLE IDENTIFICATION OF AN UHURU X-RAY SOURCE IN THE SOUTHERN SKY. Guthrie, B. N. G. (Royal Observatory, Edinburgh). Nature (London) Phys. Sci.; 240: No. 98, 43(13 Nov 1972).

It is stated that a weak x-ray source, termed 2U 0328-52, was recently detected by the Uhuru satellite. The x-ray intensity in the range 2 to 10 keV was $2.9 \times 10^{-14} J/m^2/s$. The source lies far from the galactic plane at latitude −51° and may well be extragalactic. Tentative identifications with the bright galaxies IC 1954 and NGC 1249 have been suggested, but another possibility is that the source may be related to a rich cluster of galaxies; there is strong evidence that some rich clusters are x-ray sources, and high concentrations of galaxies have been found near the position of 2U 0328-52. The x-ray emission from rich clusters of galaxies may be due to thermal bremsstrahlung of hot intergalactic gas or to inverse Compton scattering of relativistic electrons on the microwave background radiation. (UK)

8071 SEARCH FOR Hα EMISSION FROM THE COMPANION RADIO SOURCES OF SCO X-1. Vanden Bout, P. A.; Grupsmith, G.; Bopp, B. W. (Univ. of Texas, Austin). Nature (London) Phys. Sci.; 240: No. 98, 43-4(13 Nov 1972).

It is thought that the radio emission from Sco X-1 originates in an unusual triple system of sources. The three radio sources lie along a line position angle of 29° with the central source coincident in position with the star considered to be the optical counterpart of the x-ray source. All three radio sources have nonthermal spectra, and the central source is highly variable. Evidence that the companion sources are part of the Sco X-1 system, and not chance background sources, consists of the unusual collinearity of the positions and the apparent detection of a position change of one of the sources. With a view to obtaining additional evidence linking these sources to Sco X-1 an attempt was made to detect optical emission from possible nebulosity in the region near the x-ray source; as a sensitive check a search was made for Hα emission, using a standard photoelectric photometer and an Hα interference filter, in conjunction with the 107 inch telescope at the McDonald Observatory. An upper limit of 1.1 Hz was found for the excess of Hα emission from the radio source as compared with the sky. As an absolute flux the upper limit represented 4.6×10^{-3} Hα photons/cm^2/s. This low upper limit rules out the possibility of detecting optical nebulosity by photographic techniques, and proof that the three sources comprise a single system will have to come from further observations of proper motions. (UK)

8072 POPULATIONS OF EXCITED ATOMS: SENSITIVITY TO LOW-ENERGY CROSS-SECTIONS. Dupree, A. K. (Harvard Coll. Observatory, Cambridge, MS). Astrophys. Lett.; 12: No. 3, 125-8(Nov 1972).

At low energies two sets of theoretical cross-sections for electron–hydrogen collisions between highly excited atomic levels differ by more than a factor of 100. However, these different cross sections change the population of high ($n \sim 100$) atomic levels and the quantity $d\ln b/dn$ by less than a factor of 2 under the conditions of temperature, density, and radiation field expected in H I clouds. It may be possible to infer the appropriate cross sections from low-frequency observations of radio recombination lines. (auth)

8073 POSSIBLE NEW MECHANISM FOR GENERATING COHERENT EMISSION OF RADIO WAVES IN ASTROPHYSICAL PHENOMENA. Friedman, M. (Naval Research Lab., Washington, DC). Astrophys. Lett.; 12: No. 3, 129-33(Nov 1972).

A new mechanism has been observed in recent laboratory experiments for generating coherent radiofrequency emission from relativistic electrons. Intense microwave emission has been detected when relativistic electrons interact with small-scale structures of a magnetic field. A qualitative theory suggests that the mechanism incorporates processes of generation and amplification of rf waves as well as a "nonlinear" process that controls the spectral distribution. This mechanism may be important in astrophysical phenomena. (auth)

8074 OPTICAL AND RADIO FLARES IN BL LACERTA (VRO 42.22.01). Hackney, R. L. (Univ. of Florida, Gainesville); Hackney, K. R.; Smith, A. G.; (and others). Astrophys. Lett.; 12: No. 3, 147-52(Nov 1972).

In late 1971 the peculiar source BL Lac underwent an isolated optical flare of a type previously observed in OVV quasars. Although this event was followed in 55 days by a similar radio flare, examination of all available data indicates that the observations cannot be correlated by assuming a constant radio-optical delay. (auth)

8075 RADIO POLARIZATION OF THE CRAB NEBULA AT 21 cm WAVELENGTH. Duin, R. M.; Van Der Laan, H. (Sterrewacht, Leiden). Astrophys. Lett.; 12: No. 3, 177-80(Nov 1972).

Polarization and total intensity maps of the Crab Nebula, obtained at a wavelength of 21 cm by the Westerbork Synthesis Radio Telescope, are presented. The relation between the filamentary structure and the radio polarization is discussed. (auth)

8076 INTERPRETATION OF THE MICROSTRUCTURE IN PULSAR PULSES. Cole, T. W. (CSIRO, Sydney). Astrophys. Lett.; 12: No. 3, 181-3(Nov 1972).

The output from a narrow-band receiver used to study fine detail in a pulsar pulse is governed by the equations of diffraction. The diffraction structure introduced on to the received signal is a function of both the reception process and the emitted pulse shape. Study of the details of the received pulse can yield details of the true pulse shape which are beyond the currently accepted time-resolution for such a receiver. (auth)

8077 EVOLUTIONARY THERMAL MODEL FOR THE CYGNUS LOOP. Cox, D. P. (Univ. of Wisconsin, Madison). Astrophys. J.; 178: No. 1, 169-73(15 Nov 1972).

A rather approximate but self-consistent model which can explain the density, spectrum, luminosity, and velocity of the optical filaments of the Cygnus Loop as well as the spectrum, luminosity, and shell structure of its x-ray source is derived. Assuming the distance to the Loop is 770 pc, the initial blast energy is found to be $E_0 \sim 4 \times 10^{50}$ ergs, the average interstellar density $n_0 \sim 1\ cm^{-3}$, and the apparent age 45,000 years. Comparison is made with the alternative adiabatic blast-wave model which explains only the x-ray source. (auth)

8078 COOLING AND EVOLUTION OF A SUPERNOVA REMNANT. Cox, D. P. (Univ. of Wisconsin, Madison). Astrophys. J.; 178: No. 1, 159-68(15 Nov 1972).

The structure, evolution, and cooling of an old supernova remnant are reviewed and elaborated in order to provide a theoretical framework to relate remnants of different ages but with similar energies and environments. (auth)

8079 THEORETICAL STRUCTURE AND SPECTRUM OF A SHOCK WAVE IN THE INTERSTELLAR MEDIUM: THE CYGNUS LOOP. Cox, D. P. (Univ. of Wisconsin, Madison). Astrophys. J.; 178: No. 1, 143-57(15 Nov 1972).

The flow structure, spectrum, and luminosity were calculated for a model of a plane shock wave followed by a region in which the shock-heated gas cools to a low temperature and is compressed to very high densities. These calculations were compared with observations of the Cygnus Loop filaments, assuming that they are

such regions viewed edge-on. The agreement was very good for reasonable choices of model parameters. (auth)

8080 DISTANCES AND ABSOLUTE LUMINOSITIES OF GALACTIC X-RAY SOURCES. Seward, F. D.; Burginyon, G. A.; Grader, R. J.; Hill, R. W.; Palmieri, T. M. (Univ. of California, Livermore). Astrophys. J.; 178: No. 1, 131-42(15 Nov 1972).

Data from two soft x-ray surveys were combined to propose a distance scale for 20 x-ray sources. These are the bright sources that lie close to the galactic plane. A relationship between measured absorption and distance was derived by using supernova remnants with known distances for nearby objects and by requiring a rough symmetry about the galactic center for the distant sources. Based on this distance scale, the calculated absolute luminosities of the sources ranged from 10^{35} to 10^{39} ergs s^{-1}. The sources that were not identified with supernova remnants tended to fall into two groups. One group had luminosities in excess of 10^{38} ergs s^{-1}, about the same strength as the sources found in the Magellanic Clouds. These strong sources lie in a loose cluster about the galactic center. A second group of sources had luminosities that averaged approximately 10^{37} ergs s^{-1}. These weaker sources were detectable out to a distance of only about 5 kpc from the Sun. The x-ray absorption data require that the relative amount of medium-weight elements in interstellar material be greater than that of the accepted cosmic abundances, or alternatively that the density of these elements increase in the region of the galactic center. (auth)

8081 EFFECTS OF RADIATION PRESSURE FROM RESONANCE SCATTERING IN A QUASAR CLOUD. Williams, R. E. (Univ. of Arizona, Tucson). Astrophys. J.; 178: No. 1, 105-12(15 Nov 1972).

The suggestion that those absorption-line systems in quasi-stellar objects for which $Z_{abs} \ll Z_{em}$ are caused by the acceleration of clouds by radiation pressure was investigated. The transfer of resonance-line radiation in a static cloud was solved in order to determine the distribution of the force within the cloud due to radiation pressure. It is shown that radiation pressure will accelerate a discrete cloud coherently only under a restrictive range of conditions. Specifically, if the continuum radiation incident upon a cloud ultimately causes appreciable photon creation within the cloud, e.g., through ionization, the gas will tend to be disrupted by the outward diffusion of the internally created photons as it is accelerated. The conditions which are expected to prevail in the line-emitting regions of QSOs are such that line creation does produce a strong differential expansion if radiation pressure is the predominant force. (auth)

8082 DIGICON SPECTROPHOTOMETRY OF THE QUASI-STELLAR OBJECT PHL 957. Beaver, E. A. (Univ. of California, San Diego); Burbidge, E. M.; McIlwain, C. E.; Epps, H. W.; Strittmatter, P. A. Astrophys. J.; 178: No. 1, 95-103(15 Nov 1972).

Measurements of the spectral region centered on the broad Lα absorption in the QSO PHL 957 were made with the UCSD Digicon (digital image tube) at the Cassegrain focus of the Lick 120-inch (305-cm) telescope, and photographic spectra were also obtained over a wider spectral range. The broad absorption was very deep, with an intensity less than 2% of the continuum over the central 30 Å. The profile of the broad absorption and the relationship between this feature and the other multiple-redshift systems found in PHL 957 by Lowrance et al. is discussed. Absorptions arising from excited fine-structure states of some ions may be present. If the central part of the Lα feature arises in the same gas as produces the C II line at 4415 Å, the C/H ratio may be $\sim 10^2$ to 10^3 lower than normal. Alternatively, most of the Lα broad absorption may consist of multiple Lα lines arising in a gas with a velocity range exceeding 1000 km s^{-1} in which case C/H may be normal. Probably all the absorptions arise in gas associated with the QSO. (auth)

8083 OBSERVED ANISOTROPY IN THE DISTRIBUTION OF RADIO SOURCES. Yahil, A. (Inst. of Advanced Study, Princeton, NJ). Astrophys. J.; 178: No. 1, 45-55(15 Nov 1972).

The anomalous number-flux relation of the stronger radio sources, which has been interpreted as due to evolution, is shown to appear predominantly and perhaps only in the northern galactic hemisphere. Furthermore, it is due to ~40% of the sources which have not been identified optically, and whose distance is not known. It is therefore also possible that these unindentified sources are less powerful ones close by, and the irregularities in their flux density distribution is due to local inhomogeneities. It should be possible to rule out this hypothesis by pushing optical identification to $V \lesssim 22.5$, and by discovering that the presently unidentified sources indeed are giant elliptical galaxies at cosmological distances. (auth)

8084 5-KM RADIO TELESCOPE AT CAMBRIDGE. Ryle, M. (Cambridge Univ., Eng.). Nature (London); 239: No. 5373, 435-8(20 Oct 1972).

A description is given of a new telescope with which radio astronomers can now map the sky with a resolution comparable to that of the best optical telescopes. This latest advance in aperture synthesis technology should yield important new evidence on the physics of radio galaxies, quasars and supernova remnants. (auth)

8085 DIRECT MEASUREMENT OF THE LIFETIMES AND PREDISSOCIATION PROBABILITIES FOR ROTATIONAL LEVELS OF THE OH AND OD A ^{2}SIGMA$^+$ STATES. Elmergreen, B. G.; Smith, W. H. (Princeton Univ., NJ). Astrophys. J.; 178: No. 2, 557-64(1 Dec 1972).

Quantitative measurements for the lifetimes and predissociation probabilities for the F_1 and F_2 components for individual rotational lines of the A $^2\Sigma^+$ state for OH and OD molecules were obtained from absolute phase-shift measurements. It was found that the lifetimes of the F_1 and F_2 components show effects from a series of predissociations and from mixing with the ground state. The comparison of the individual rotational-line lifetimes with those found in the Hanle effect now show good agreement. Astrophysical implications of preassociation in OH are indicated. (auth)

8086 UHURU CATALOG OF X-RAY SOURCES. Giacconi, R.; Murray, S.; Gursky, H.; (and others) (American Science and Engineering, Cambridge, MA). Astrophys. J.; 178: No. 2, 281-308(1 Dec 1972).

A catalog of x-ray sources observed with the Uhuru satellite is presented. About 70 days of data were analyzed for this catalog resulting in 125 sources. Approximately two-thirds of the sources are located within ±20° of the galactic plane. Some of the sources at higher galactic latitudes are identified with known extragalactic objects. Most of the strong sources near the galactic plane are found to be variable. (auth)

8087 OBSERVATIONS OF THE EXTENDED X-RAY SOURCES IN THE PERSEUS AND COMA CLUSTERS FROM UHURU. Forman, W. (Harvard Coll., Cambridge, MA); Kellogg, E.; Gursky, H.; Tananbaum, H.; Giacconi, R. Astrophys. J.; 178: No. 2, 309-16(1 Dec 1972).

The x-ray source in Perseus identified as NGC 1275 is found to have a finite angular extent of about 35 arc minutes. The improved location of the center of the emission is consistent with NGC 1275. An improved location for the center of the Coma X-1 source is consistent both with the kinematic center of the cluster and with NGC 4874. The Perseus x-ray spectrum fits a power-law index of 1.09 ± 0.07; the Coma spectrum fits either a power law of index 1.01 ± 0.10 or a thermal-bremsstrahlung spectrum with kT = 5.3 ± 0.6 keV. These extended sources — Coma, Perseus, and the source in the Virgo cluster — may be a new class of x-ray objects associated with active galaxies in rich clusters. (auth)

8088 ROTATING BLACK HOLES: LOCALLY NONROTATING FRAMES, ENERGY EXTRACTION, AND SCALAR SYNCHROTRON RADIATION. Bardeen, J. M. (Univ. of Washington, Seattle); Press, W. H.; Teukolsky, S. A. Astrophys. J.; 178: No. 2, 347-69(1 Dec 1972).

A technique is outlined for analyzing physical processes around rotating black holes. The technique is based on the orthonormal frames of "locally nonrotating observers." As one application of the technique, it is shown that the extraction of the rotational energy of a black hole, although possible in principle (e.g., the "Penrose–Christodoulou" process), is unlikely in any astrophysically plausible context. As another application, it is shown that, in order to emit "scalar synchrotron radiation," a particle must be highly relativistic as seen in the locally nonrotating frame — and can therefore not move along an astrophysically reasonable orbit. A number of useful formulae for particle orbits in the Kerr metric is included, many of which have not been published previously. (auth)

8089 SOFT X-RAY SPECTRA OF THE CYGNUS LOOP AND CYGNUS X-2 IN THE ENERGY RANGE 0.16 TO 6.7 keV. Bleeker, J. A. M. (Kamerlingh Onnes Lab., Leiden); Deerenberg, A. J. M.; Yamashita, K.; Hayakawa, S.; Tanaka, Y. Astrophys. J.; 178: No. 2, 377-87(1 Dec 1972).

Soft x-ray spectra of the Cygnus Loop and Cyg X-2 were obtained during flight of a rocket borne soft x-ray experiment on May 26, 1971. The spectrum of the Cygnus Loop is best represented by thermal bremsstrahlung of a plasma at 2.7×10^{6}° K with interstellar absorption of 5.5×10^{20} H atoms cm^{-2}. It is unnecessary to invoke a strong line near 0.60 keV as reported by Gorenstein et al. The soft x-ray spectrum of Cyg X-2 indi-

cates a column density which is compatible with that expected for its optical counterpart. (auth)

8090 MOLECULAR CALCULATIONS CONCERNING A NEW CANDIDATE FOR THE UNIDENTIFIED EMISSION LINE AT 89.190 GHz. Barsuhn, Juergen (Max-Planck-Institut fuer Radioastronomie, Bonn). Astrophys. Lett.; 12: No. 3, 169-72 (Nov 1972).

SCF-calculations indicate that the electronic ground state of the radical CCH is a $^2\Sigma^+$ state. The computed rigid-rotor, $J = 1 \rightarrow 0$, transition-frequency of $^2\Sigma^+$ is 88.9 GHz, which coincides within the error limits of the approximation to the X-ogen frequency at 89.190 GHz. (auth)

8091 LABORATORY OBSERVATION OF THE $0_{00} \rightarrow 1_{01}$ TRANSITIONS FOR THE HCO AND DCO FREE RADICALS BY MICROWAVE SPECTROSCOPY. Saityo, Shuji (Sagami Chemical Research Center, Sagamihara, Japan). Astrophys. J.; 178: No. 2, L95-7(1 Dec 1972).

The frequencies of the hyperfine components of the $1_{01} \rightarrow 0_{00}$ transitions for the HCO and DCO radicals were measured with laboratory microwave spectroscopy. (auth)

8092 3C 120, BL LACERTAE, AND OJ 287: COORDINATED OPTICAL, INFRARED, AND RADIO OBSERVATIONS OF INTRADAY VARIABILITY. Epstein, E. E. (Aerospace Corp., Los Angeles); Fogarty, W. G.; Hackney, K. R.; (and others). Astrophys. J.; 178: No. 2, L51-9(1 Dec 1972).

Simultaneous optical, infrared, and radio observations were made to search for intraday (time-scale < 24h) variability of the radiation from 3C 120, BL Lac, and OJ 287, sources known to be active at both radio and optical wavelengths on time scales of days or longer. Optical interday variability was found for all three sources. The finding of optical intraday variability for BL Lac verified earlier results. The 3.5-mm data strongly suggest intraday variations of OJ 287 with amplitudes as large as ~40%. The infrared data for OJ 287 show variability of ~25% on one night but show no correlation with the 3.5-mm data. (auth)

8093 HARD X-RAY OBSERVATIONS OF HERCULES X-1 BY OSO-7. Ulmer, M. P.; Baity, W. A.; Wheaton, W. A.; Peterson, L. E. (Univ. of California, San Diego). Astrophys. J.; 178: No. 2, L61-4(1 Dec 1972).

The UCSD x-ray telescope on the OSO-7 scanned the periodic variable x-ray source Her X-1 from May 30 to June 1, 1972. Analysis of the quick-look data in the 7 to 26-keV range showed low intensity at ~12 _ 2 hours UT, May 31, 1972, which was expected from the previously determined 1.7-day period. The source was observed in its high-intensity state ~30 hours earlier than predicted from the Uhuru determination of the 35.7-day period and its phase. The spectrum over the ~2 to 40-keV range in the high-intensity state can be fitted by $\sim 0.25/E^{1.3}$ photons $(cm^2\ s\ kev)^{-1}$. (auth)

8094 SPECTROSCOPIC OBSERVATIONS OF HZ HERCULIS AND A MODEL FOR HERCULES X-1. Crampton, David; Hutchings, J. B. (Dominion Astrophysical Observatory, Victoria, B. C.). Astrophys. J.; 178: No. 2, L65-9(1 Dec 1972).

Ten spectrograms of HZ Her were obtained, through its 1.7-day period, at dispersions of 78 and 118 Å mm^{-1}. The spectrum is peculiar, varying in mean spectral type from early B at maximum to late A at minimum light. An ultraviolet continuum disappears during x-ray eclipse. A mean velocity variation is indicated through the 1.7-day period, out of phase with the x-ray source. The optical light curve can be synthesized by a model consisting of a small hot object and a normal A-type star at its inner Roche limiting surface. (auth)

8095 DISCOVERY OF THE BINARY NATURE OF SMC X-1 FROM UHURU. Schreier, E.; Giacconi, R.; Gursky, H.; Kellogg, E.; Tananbaum, H. (American Science and Engineering, Cambridge, Mass.). Astrophys. J.; 178: No. 2, L71-5(1 Dec 1972).

The x-ray source SMC X-1 in the Small Magellanic Cloud was found to undergo periodic intensity changes which were interpreted as eclipses in a binary system. The phase of the center of occultation is given by UT [1971 January $12.99 \pm 0.02 + n(3.8927 \pm 0.0010)$]. No regular pulsations of the source on timescales of seconds were detected with an upper limit on the percentage pulsed of 10%. Intensity fluctuations on timescales of hours and possibly minutes were observed. Extended nonperiodic intervals of low intensity were also noted. The energy spectrum is flat and shows low-energy absorption, similar to the behavior of other binary x-ray sources. A possible correlation between low-energy cutoff and orbital inclination in binaries is discussed. (auth)

Solar Phenomena

Refer also to abstracts 8040, 8170, 8175, 8177, 8198, 8214, 8216, and 8218.

8096 (AD-741783) RESEARCH DIRECTED TOWARD THE OBSERVATION AND INTERPRETATION OF SOLAR PHENOMENA. Final Report, November 1, 1968-December 31, 1971. Bell, B.; Menzel, D. H. (Harvard Coll. Observatory, Cambridge, Mass.). Jan 1972. Contract F19628-69-C-0077. 23p. (AFCRL-72-94). NTIS.

The first section summarizes the theoretical studies carried out on sunspot models, cosmic electrodynamics, and atomic theory. The second section describes coronal studies at eclipse. The third section reviews a study of some statistical properties of sunspot cycles, with emphasis on their variation from cycle to cycle, with evidence for long-period fluctuation in solar activity which is not confined to the usual indices of spottedness. The concluding section is concerned primarily with long-term solar variations and climate history, including some research directed toward fuller identification of the climate fluctuations of the past century. (auth) (GRA)

8097 (AD-742290) DESIGN OF A NUMERICAL SOLAR DYNAMO MODEL. Final Scientific Report, February 1, 1969-December 31, 1971. Gordon, C. T. (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology). 31 Jan 1972. Contract F19628-69-C-0042. 132p. (AFCRL-72-101). NTIS.

A numerical, baroclinically driven, nonlinear, hydromagnetic dynamo model, which resembles Gilman's (1969) model, is formulated and applied to the Sun. According to the baroclinic hypothesis, a stably stratified, but baroclinically unstable region is imbedded inside the convection zone. Because it is impossible at present, to verify this rather ad hoc hypothesis observationally, only the plausibility of a baroclinic dynamo model for the Sun is investigated. More specifically, is it capable of simulating and maintaining the solar differential rotation and/or large scale solar magnetic fields. The model incorporates properties of fluid dynamos and of rotating geophysical fluids. (GRA)

8098 (AD-743193) CHARGED-PARTICLE TRANSPORT IN TURBULENT ASTROPHYSICAL PLASMAS. Newman, C. E. Jr. (Stanford Univ., Calif. Inst. for Plasma Research). 14 Mar 1972. Contract N00014-67-A-0112-0062. 82p. (SU-IPR-461). NTIS.

The effect of electromagnetic fluctuations, or plasma turbulence, on the motion of the individual particles in a plasma is investigated; two alternative methods are used to find a general equation governing the time evolution of a distribution of charged particles subject to both an external force field and the random fields of the fluctuations. It is found that, for the high-temperature, low-density plasmas frequently encountered in the study of astrophysics, the presence of even a small amount of turbulence can have a very important effect on the behavior of the plasma. Two problems in which turbulence plays an important role are treated in detail. (GRA) (auth)

8099 (AD-745167) STUDY OF THE RADIO FREQUENCY SPECTRUM OF THE SUN. Final Report, April 1, 1969-January 31, 1972. Maxwell, A. (Harvard Radio Astronomy Station, Fort Davis, Tex.). Apr 1972. Contract F19628-69-C-0033. 20p. (AFCRL-72-224). NTIS.

Research on the spectral characteristics of radio bursts from the Sun is summarized. (GRA)

8100 (AD-745323) RESEARCH IN THE FIELD OF SOLAR RADIO NOISE AS WELL AS OPTICAL SUNSPOT PHENOMENA. Final Report, February 1, 1967-January 31, 1972. Elgaroey, O.; Jensen, E. (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 25 Mar 1972. Contract F61052-67-C-0070. 56p. (AFCRL-72-334). NTIS.

The researches cover the general field for solar radio noise and optical solar phenomena. Special interest has been focused on the following items: radio noise storms, short-lasting bursts, wave propagation in the corona, burst chains, the K-line of Ca II, the velocity field around sunspots, line formation, magnetic fields in sunspots, sunspot statistics and sunspot models and, finally, abundance determinations of chemical elements on the Sun. (GRA)

8101 SOLAR ACTIVITY AND THE ROTATION OF JUPITER. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.); Pokorny, Z. Astrophys. Lett.; 12: No. 3, 173-5(Nov 1972).

The relation between solar activity and the rotational periods of surface features on Jupiter was investigated over the period 1880-1968. Chree's superposition analysis shows that the mean rotational periods of the features display a double-maximum relationship in the course of the 11-yr solar cycle. (auth)

8102 SPECTRA OF HIGHLY IONIZED ALUMINUM (Al VI-X) IN THE EXTREME-ULTRAVIOLET AND SOFT X-RAY REGIONS. Valero, F. P. J.; Goorvitch, D. (Ames Research Center, Moffet Field, CA). Astrophys. J.; 178: No. 1, 271-6 (15 Nov 1972).

Spectral lines corresponding to transitions in the five-to-nine-

times-ionized Al atom were measured and classified in the spectral range from 48 to 340 Å. The spectra were photographed by using a laser-produced plasma as a light source and a 3-m grazing-incidence spectrograph. Different techniques employed to separate stages of ionization are discussed. (auth)

8103 POSSIBLE NEW INTERPRETATION OF POWER SPECTRA OF SOLAR-GRANULATION BRIGHTNESS FLUCTUATIONS. Nakagawa, Y.; Priest, E. R. (High Altitude Observatory, Climax, CO). Astrophys. J.; 178: No. 1, 251-5(15 Nov 1972).

The brightness fluctuations of solar granulation are attributed to local temperature fluctuations through the photosphere. It is plausible to consider that the temperature fluctuations result from a passive response of temperature to turbulent fluid convections. The theoretical spectrum governing such a passive response given by Batchelor is compared with the power spectra derived by Edmonds from Stratoscope photographs, and it is shown that a satisfactory agreement can be obtained. Discrepancies between this result and observations from the ground are discussed. (auth)

8104 FREE–FREE ABSORPTION OF GYROSYNCHROTRON RADIATION IN SOLAR MICROWAVE BURSTS. Ramaty, Reuven (Goddard Space Flight Center, Greenbelt, MD); Petrosian, Vahe. Astrophys. J.; 178: No. 1, 241-9(15 Nov 1972).

A model for solar microwave bursts is considered in which, over a broad frequency band, the flux density is a slowly varying function of frequency. It is proposed that such an essentially flat spectrum could result from free–free absorption of gyrosynchrotron emission of nonthermal electrons accelerated in solar flares. The theory of gyrosynchrotron radiation is reviewed; simplified formulae for the Razin effect, self-absorption, and gyroresonance absorption are given; and their range of validity is discussed. Using these results, the thermal electron density, temperature, emission measure, magnetic fields, and number of nonthermal electrons in the emitting region are evaluated for a flare with a flat microwave spectrum. (auth)

8105 SOLAR-WIND MODEL INCLUDING PROTON THERMAL ANISOTROPY. Whang, Y. C. (Catholic Univ. of America, Washington, DC). Astrophys. J.; 178: No. 1, 221-39(15 Nov 1972).

Near 1 AU the solar-wind plasma is observed to be two-fluid in nature: the electrons and protons have two different temperatures. Near the Sun, there is sufficient interaction between them so that in the region $r < 0.1$ AU the solar wind is one-fluid in nature: the electrons and protons have the same isotropic temperature. The exchange of energy weakens at distances far away from the Sun; and the solar-wind protons become completely collisionless in the region $r > 0.5$ AU. Between the one-fluid and the collisionless regions there is a transitional region where the flow is neither one-fluid nor completely collisionless. The present model divides the interplanetary space into two regions: it assumes that the solar wind is one-fluid in an "inner region" $r < 0.4$ AU and two-fluid and collisionless in an "outer region" $r > 0.4$ AU. The second and third third moment equations of the Vlasov equation together with other conservation equations are used to govern the solar-wind flow in the outer region. The model produces solutions for all macroscopic quantities as well as for the microscopic proton distribution function as functions of heliocentric distances up to 50 AU and beyond. The calculated results at 1 AU give the following values: the solar-wind velocity $u = 331$ km s^{-1}, the electron temperature $T_e = 1.52 \times 10^5$°K, the proton temperature $T_i = 7.5 \times 10^4$°K, the proton thermal anisotropy $T_{||}/T_{\perp} = 2.23$, the number density $n = 5.5$ protons cm^{-3}, the electron heat flux $q_e = 4.9 \times 10^{-3}$ ergs s^{-1} cm^{-2}, the proton heat flux $q_i = 1.1 \times 10^{-4}$ ergs s^{-1} cm^{-2}, the magnitude of the magnetic field $B = 6.3$ gammas, the direction angle of the field $\phi = 130°$, and the plasma beta value $\beta = 1.09$. They are in good agreement with observations. The predicted distribution function at 1 AU also resembles the distribution function reconstructed from observational data. (auth)

8106 POLARIMETRIC STUDY OF THE ANOMALOUS ABSORPTION OF COSMIC RADIO WAVES IN THE IONOSPHERE AT MIDLATITUDES. Antonov, A. V. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 2, 199-203(1972).

Translated from Kosm. Issled.; 10: No. 2, 223-7(1972).

The anomalous absorption in the ionosphere is found experimentally to be produced at a height of ≈60 km. The dependence of the height of the anomalous absorption on the solar zenith distance is determined. A correlation is established between the maximum of the anomalous absorption and the time and amplitude characteristics of solar flare emission in the 1-to-8-Å band. The temperature of the layer responsible for the anomalous absorption is shown to remain constant to within 20% during a flare. This analysis implies that the spectrum of any sequence of 1-to-8-Å x-ray bursts generated within a small region of the solar disk will remain constant in form during the activity of that region. (auth)

8107 PROBLEM OF SOLAR CYCLE VARIATION OF THE INTENSITY OF EXCESS RADIATION AT SMALL HEIGHTS. Tsaplin, V. S. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 2, 275-6(1972).

Translated from Kosm. Issled.; 10: No. 2, 301-2(1972).

During the period 1965–1969 radiation measurements were made on the Kosmos satellites with a gas-discharge counter in orbits with apogee of ~350 km and perigee of ~200 km at an angle of 65°. Electrons above 8 MeV and protons above 60 MeV were recorded. (W.D.M.)

8108 MEASUREMENTS OF THE INTENSITY OF SOLAR L_α-EMISSION BY NONOPTICAL METHODS USING THE VERTICAL-1 ROCKET. Martini, L.; Shuette, N. M.; Gringaus, K. I.; Stark, B. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 2, 227-31(1972).

Translated from Kosm. Issled.; 10: No. 2, 255-60(1972).

The results of experiments on the measurement of the intensity of solar ultraviolet emission in the L_α line, which were performed by means of a photoelectron analyzer and a Lyman alpha-photometer on the Vertical-1 rocket are described. The intensity of solar L_α-emission based on data obtained from a photoelectron analyzer turned out to equal 3.63 and 4.40 erg/cm^2·sec, respectively. A comparison of these values, which were obtained using completely different instruments, is evidence of the fairly good agreement of the data if the error of the measurement is taken into account. The comparison made between the results presented and the results of a number of experiments performed both by other authors and by the authors of the present paper indicates comparatively small time variations of solar L_α-emission. (auth)

8109 SUN'S DIFFERENTIAL ROTATION AND POLE–EQUATOR TEMPERATURE DIFFERENCE. Durney, B. (National Center for Atmospheric Research, Boulder, CO). Solar Phys.; 26: No. 1, 3-7(Sep 1972).

The Sun's differential rotation can be understood in terms of a preferential stabilization of convection (by rotation) in the polar regions of the lower part of the convection zone (where the Taylor number is large). A significant pole–equator difference in flux (ΔF) can develop deep inside the convection zone which would be unobservable at the surface, because ΔF can be very efficiently reduced by large scale meridional motions rising at the poles and sinking at the equator. This is the sense of circulation needed to produce the observed equatorial acceleration of the Sun. Differential rotation is generated, therefore, in the upper part of the convection zone (where the interaction of rotation with convection is small) and results as the convection zone adjusts to a state of negligible Taylor number. (auth)

8110 SOLAR ROTATION AS MEASURED IN EUV CHROMOSPHERIC AND CORONAL LINES. Simon, G. W. (Air Force Cambridge Research Labs., Sunspot, NM); Noyes, R. W. Solar Phys.; 26: No. 1, 8-14(Sep 1972).

Active regions were followed across the disk on OSO 4 spectroheliograms in the Lyman continuum (LC) and in Mg × λ625. These observations indicate differential rotation with latitude, but not with height in the atmosphere. The measured equatorial sidereal rotation velocity is 14.7 ± 0.2° per day in both chromospheric LC and coronal Mg x, where the quoted error is the standard deviation of a least-squares fit to the data. (auth)

8111 DIFFERENTIAL ROTATION IN THE SOLAR ATMOSPHERE INFERRED FROM OPTICAL, RADIO, AND INTERPLANETARY DATA. El-Raey, Mohamed (Univ. of California, Berkeley); Scherrer, P. H. Solar Phys.; 26: No. 1, 15-20(Sep 1972).

Autocorrelation analysis of sunspot number, solar radio flux, and interplanetary field in the period 1967 to 1970 yields new information concerning solar atmospheric rotation. The upper chromosphere and the lower corona are rotating on the average about 5 to 8% faster than is either the photosphere or the upper corona. In addition, short-lived features in the chromosphere and lower corona are found to rotate sometimes as much as 10% faster than relatively long-lived features at the same height. Coronal and photospheric features are found to rotate more or less synchronously. Analysis of yearly data has indicated a considerable change in rotation periods from one year to another. (auth)

8112 FORMATION OF Mg I 4571 Å IN THE SOLAR ATMOSPHERE. I. A MODEL ANALYSIS OF A ONE-DIMENSIONAL STATIC ATMOSPHERE. Altrock, R. C.; Cannon, C. J. (Univ. of Sydney). Solar Phys.; 26: No. 1, 21-9(Sep 1972).

A one-dimensional analysis of the 4571 Å line of neutral magnesium is presented. The Harvard–Smithsonian Reference Atmosphere (HSRA) and the Bilderberg Continuum Atmosphere (BCA) are used to compute the emergent line profiles at various positions on the solar disc. The resultant profiles, when compared to the observations, indicate that the HSRA electron temperature

distribution is a more satisfactory representation of the solar atmosphere in the region of the temperature minimum than is the BCA. A slight modification to the HSRA is suggested which reduces the minimum temperature to 4140K and enables an even more satisfactory "fit" to the available data. (auth)

8113 MEAN VALUES IN INHOMOGENEOUS ATMOSPHERES. Wilson, P. R.; Williams, N. V. (Univ. of Sydney). Solar Phys.; 26: No. 1, 30-41(Sep 1972).

A brief summary of observations of inhomogeneities in the solar atmosphere and progress in the theoretical analysis of two-dimensional model atmospheres is given. In particular, it is asserted that reliable reference models of the mean temperature, pressure, etc. may be derived only by averaging over the horizontal coordinates of a two- or three-dimensional model. In discussion of a wide variety of cases including strong chromospheric lines, weak photospheric lines, and continuum radiation, it is shown that although the derivation of mean values by first averaging over the fluctuations in the data and then applying a one-dimensional analysis is an obvious first approximation, it may lead to errors of a gross qualitative nature. Thus the recent deductions by several authors of very small temperature gradients in the upper regions of sunspots are shown to be subject to considerable doubt. (auth)

8114 INTERPRETATION OF ABSORPTION-LINE SHIFTS IN THE SOLAR SPECTRUM. Kostik, R. I.; Orlova, T. V. (Main Astronomical Observatory, Kiev). Solar Phys.; 26: No. 1, 42-51(Sep 1972).

The shifts of Fraunhofer lines of different chemical elements in a homogeneous medium with plane monochromatic progressive adiabatic sound waves are derived. The calculations indicate that lines of neutral elements ($6 \leq \chi_0 \leq 14$) with lower excitation potentials $\chi_{0i} = 0$ to 2 eV are red shifted, those with excitation potential $\chi_{0i} = 4$ to 12 eV are blue shifted, and with $\chi_{0i} = 3$ eV are both blue and red shifted. The lines of ions are shifted toward the blue. The shifts of Fraunhofer lines are found to decrease from the center of the solar disk to the limb. These results agree qualitatively and quantitatively with observations. (auth)

8115 STRUCTURE OF SUNSPOTS. I. OBSERVATIONAL CONSTRAINTS: CURRENT SHEET MODELS. Gokhale, M. H.; Zwaan, C. (Astronomical Inst., Utrecht). Solar Phys.; 26: No. 1, 52-75(Sep 1972).

As a first step in constructing three-dimensional decaying sunspot models the relevant observational data are selected. From these it is concluded: (i) sunspots, except the smallest, obey a radial and evolutionary similarity; (ii) sunspots may be considered as isolated, fairly well defined flux tubes, wrapped in thin current sheets; (iii) a substantial number among stable regular spots show a phase of slowest decay whose rate is independent of the spot's area. Arguments are given that the slowest rate of decay is ultimately determined by Ohmic dissipation in the inner part of the current sheet. Preliminary asymptotic models for the deep layers (deeper than 2000 km below the photosphere) are given which satisfy the above three constraints. To meet the observed rate of slowest decay the current sheet has to be very thin, about 10^{-5} to 10^{-4} times the umbral radius. Radial large-scale fluid motions are required in the current sheet to maintain the similarity of the structure. The radial motions are linked with the vertical motions which may be connected with the Evershed flow. Details are discussed which are less relevant in the large-scale structure of stable sunspots, such as fine structures, twists, the breakdown of the similarity and the relation between sunspots and smaller magnetic structures, and the intrinsic scatter in some observed quantities. (auth)

8116 OBSERVATIONS OF THE INTENSITY OF THE PENUMBRA OF SUNSPOTS. Maltby, P. (Univ. of Oslo). Solar Phys.; 26: No. 1, 76-82(Sep 1972).

Observations of the penumbral intensity of sunspots in 13 wave length regions are presented. In 4 wavelength regions 54 sunspots were measured. In the other wavelength regions the number of sunspots considered ranged from 3 to 19. The penumbral intensity altered with position within the spot. This intensity variation was found to be comparable with the change in intensity from one spot to another. The penumbral intensity was found to be independent of spot size in the sample considered. The penumbra model of Kjeldseth, Moe, and Maltby (1969) with $\Delta\theta = 0.055$ was supported by the measurements. (auth)

8117 CALCULATION OF 5250.216 Å LINE PROFILES IN SUNSPOTS. Dunn, A. R. (Teledyne Brown Engineering, Huntsville, AL). Solar Phys.; 26: No. 1, 83-6(Se 1972).

The assumptions of pure absorption and local thermodynamic equilibrium are sometimes used to calculate approximate spectral line profiles in cases where a rigorous treatment is impractical or impossible. In certain conditions, the profile is not completely defined under these assumptions. (auth)

8118 MINIMUM INTENSITY OF THE NaD_2-5890 Å LINE IN SUNSPOT UMBRA. Fay, T.; Remo, J.; Czaja, K. (Franklin Inst., Swarthmore, PA). Solar Phys.; 26: No. 1, 87-9(Sep 1972).

The line-to-continuum intensity ratio for the center of the Na D_2 absorption line in a spot of area 20×10^{-6} in the Rome Group 5847 was found to be 0.033 ± 0.05 on 6-7/7/70 by two methods. (auth)

8119 WATER VAPOR IN SUNSPOTS. Staveland, L. (Univ. of Oslo). Solar Phys.; 26: No. 1, 90-3(Sep 1972).

The line intensities were calculated at temperatures of 263 K and 3500 K for the H_2O band 201 at 0.94 μm. The possibility of detecting these lines in sunspots is discussed. The amount of H_2O was estimated to be 4.2×10^{20} molecules or 0.013 g cm^{-2} above optical depth equal to unity. However, other bands at longer wavelengths are more favorable for detection of H_2O. (auth)

8120 SOME OBSERVATIONAL RESULTS ON MOUSTACHES. Bruzek, Anton (Fraunhofer Institut, Freiburg, i. B.). Solar Phys.; 26: No. 1, 94-107(Sep 1972).

The results of new observations of moustaches in Hα filtergrams and in Hα spectra are presented and their relations to photospheric and chromospheric phenomena are studied. The main findings and conclusions are: (1) previous results on basic data (size, brightness, lifetime, etc.) are essentially confirmed; (2) limb observations located the moustaches at the base of the structured Hα chromosphere, just above the level of the emission of Hα ± 1 Å. At the disk moustaches are, in general, covered by absorbing and slightly Doppler-shifted chromospheric elements which determine the Hα core in the moustache spectrum. However, absorption-free moustaches with an Hα emission core revealing a pure (true) moustache spectrum have also been found; (3) moustaches have been found to coincide with continuous facular granules; it is suggested that they are an extension of facular granules into the chromosphere rather than a low-level flare-like phenomenon. (auth)

8121 ANALYSIS OF SOME ASPECTS OF 25 CHROMOSPHERIC EVENTS. I. REDUCTION OF THE OPTICAL DATA. Falciani, R. (Capodimonte Observatory, Naples); Rigutti, M.; Macris, C. J. Solar Phys.; 26: No. 1, 108-13(Sep 1972).

Some twenty-five solar events photographed at the National Observatory, Athens, were used for the production of isophotal contours. Curves showing the development with time of the energy emitted by the events at several intensity levels were obtained. Examples are shown and general remarks about measurements of flares are made. (auth)

8122 ANALYSIS OF SOME ASPECTS OF 25 CHROMOSPHERIC EVENTS. II. DISCUSSION ON THE OPTICAL DATA. Falciani, R.; Rigutti, M. (Capodimonte Observatory, Naples). Solar Phys.; 26: No. 1, 114-29(Sep 1972).

The discussion of the development curves of several solar flares observed in the Hα-line leads to some new information about the photometric structure and behavior of flares of importance from 1 to 2. The main results are as follows. An Hα-flare appears to be a pulsating phenomenon which, after an initial contraction, rapidly reaches its maximum and then exponentially grows fainter with time. Analytical representations for both the pulsation periods and the exponential decreases are given. Many of the aspects of the flare phenomenon are more violent as the considered intensity level is higher. A discussion on the present day state of solar patrol and some suggestions to improve it to be useful for solar physics are also made in the light of the present analysis. (auth)

8123 MAGNETIC STRUCTURE OF ARCH FILAMENT SYSTEMS. Frazier, E. N. (Aerospace Corp., El Segundo, CA). Solar Phys.; 26: No. 1, 130-41(Sep 1972).

Photographic-type magnetograms were used in conjunction with Hα filtergrams to study the structure and evolution of magnetic fields associated with arch filament systems. The magnetograms showed that the opposite ends of the arch filaments are indeed rooted in photospheric magnetic fields of opposite polarity. Furthermore, these magnetic field systems are in every case new magnetic flux appearing at the solar surface. Time lapse studies showed the detailed process by which the flux tubes emerge through the surface. First, supergranules bring individual strands of magnetic flux to the surface and sweep the two feet of the flux tube to opposite sides of the supergranule. Then, the flux tube rises through the chromosphere, creating a visible arch filament. It is also shown that the observed rotation of the axis of an arch filament system in the plane of the solar surface is caused by the emergence of successive flux loops, each possessing different axial tilts. (auth)

8124 COMMENTS ON THE PAPER "FINE STRUCTURE OF SOLAR MAGNETIC FIELDS" BY H. ZIRIN. Frazier, E. N. (Aerospace Corp., Los Angeles). Solar Phys.; 26: No. 1, 142-7 (Sep 1972).

Zirin (1972) contended that it is possible to deduce the chromospheric vector magnetic field from Hα filtergrams, and presented a number of rules for deduction of the magnetic field. The author disagrees with Zirin and points out four fallacies. A reply by Zirin in included which defends his original conclusions. (W.D.M.)

8125 REPLY TO "THE RELATIONS BETWEEN CHROMOSPHERIC FEATURES AND PHOTOSPHERIC MAGNETIC FIELDS" BY E. N. FRAZIER. Foukal, Peter; Zirin, Harold (California Inst. of Tech., Pasadena). Solar Phys.; 26: No. 1, 148-50(Sep 1972).

Frazier (1972) has criticized the conclusions of Zirin (1971, 1972), Veeder and Zirin (1970), and those of Foukal (1971a, b, c) on the relation between Hα structure and magnetic fields. A reply to these criticisms is given. (W.D.M.)

8126 SELF ABSORPTION OF GYRO-SYNCHROTRON EMISSION IN A MAGNETIC DIPOLE FIELD: MICROWAVE IMPULSIVE BURST AND HARD X-RAY BURST. Takakura, Tatsuo (Tokyo Univ.). Solar Phys.; 26: No. 1, 151-75(Sep 1972).

The gyro-synchrotron emission from a model source with a nonuniform magnetic field is computed taking into account the self absorption. This model seems adequate not only to interpret the radio spectrum and its time variation of microwave impulsive bursts but also to solve the discrepancy between the numbers of nonthermal electrons emitting radio burst and those emitting hard x-ray burst. The decrease of flux of radio burst with decreasing frequency at low microwave frequencies is due to the self absorption and/or the thermal gyro-absorption. In this frequency range, the radio source is optically thick even at weak microwave bursts. The weakness of the bursts may be rather due to the small size of the radio source and/or the weakness of the magnetic field than the small number density of the nonthermal electrons. The time variation of the flux of radio burst may be mainly attributed to the variation of source size in a horizontal direction (Φ direction) instead of the variation of the number density of nonthermal electrons itself, implying that the acceleration region progressively moves in the horizontal direction leaving the nonthermal electrons behind during the increasing phase of the radio burst. (auth)

8127 RADIO EVIDENCE OF TWISTED BI-POLAR MAGNETIC FIELDS IN THE SOLAR CORONA. McLean, D. J.; Sheridan, K. V. (CSIRO, Sydney). Solar Phys.; 26: No. 1, 176-82(Sep 1972).

Observations of bi-polar Type I storm centers with the Culgoora radioheliograph operating at 80 MHz show that in many cases they are not oriented as one should expect for emission in the ordinary mode and for the simplest magnetic field geometry. This is interpreted as evidence for a twist in the magnetic field. (auth)

8128 CORONAL SURVEY IN X-RAYS OF O VII AND Ne IX. Acton, L. W. (Lockheed Palo Alto Research Lab., Palo Alto, CA); Catura, R. C.; Meyerott, A. J.; Wolfson, C. J.; Culhane, J. L. Solar Phys.; 26: No. 1, 183-201(Sep 1972).

Some results of a rocket experiment flown on April 29, 1971 are reported. A survey of the solar corona was carried out with a pair of collimated Bragg spectrometers to study the resonance, intersystem, and forbidden line emission from the helium-like ions O VII (22 Å) and Ne IX (13 Å). In the direction of dispersion the collimator provided a field of view of 1.7′. Also, the continuum radiation near 3 Å was monitored by a collimated proportional counter within a view angle of 4.2′. The observed x-ray emission came from the general corona, seven plage regions, and one dynamic feature—the late stage of a small flare. From the intensity of the O VII and Ne IX resonance lines the electron temperature and emission measure of the individual emitting regions were derived on the basis of two models, one (a) in which the region was assumed to be isothermal and another (b) in which the emission measure decreased exponentially with increasing temperature. The latter model, which is the most adequate of the two, yields for the electron temperature of the time-varying feature 2 to 3 × 10^6°K, for the other active regions 1.5 to 2.5 × 10^6°K, and for the general corona 1.3 to 1.7 × 10^6°K. The Ne IX emitting regions are about 1.5 times as hot as the O VII regions. The emission measure ranges from 0.4 to 2.3 × 10^{48} cm^{-3} for all active regions and is about 2 × 10^{49} cm^{-3} for one hemisphere of the general corona above 10^6°K. From an analysis of the ratio, R, of the forbidden and intersystem lines of O VII it is concluded that none of the regions producing these lines at the time of the rocket flight had electron densities exceeding about 3 × 10^9 cm^{-3}. The data demonstrate a dependence of R upon temperature in agreement with the theory of Blumenthal et al. (1971). The wavelengths for the intersystem, the $1s^2 2s^2 S^e - 1s2p2s^2 P^0$ satellite, and the forbidden transition show in the case of Ne IX improved agreement with predictions. The observed strength of the satellite lines for both O VII and Ne IX agrees with the predictions of Gabriel's (1972) theory, which attributes their formation to dielectronic recombination. (auth)

8129 EVOLUTION OF CORONAL HELMETS DURING THE ASCENDING PHASE OF SOLAR CYCLE 20. Hansen, S. F.; Hansen, R. T.; Garcia, C. J. (National Center for Atmospheric Research, Boulder, CO). Solar Phys.; 26: No. 1, 202-24(Sep 1972).

The principal polar-crown coronal helmet structures were selected from nearly three years (May, 1965–January, 1968) of K-coronameter observations made at Haleakala and Mauna Loa, Hawaii. Six isolated and long-lived helmet systems were found at latitudes of 45° and above. Their developments are compared with underlying chromospheric and photospheric activity and a simple phenomenological model is presented showing that a coronal system is formed over an active region. Thereafter the center of gravity of the system gradually drifts poleward with the trailing unipolar magnetic region (UMR), and it becomes a high-latitude coronal helmet, arched over a polar crown filament. By comparison of these coronal helmets with observations of the outer corona (to circa 4 $R_\odot$) made at solar eclipse, lunar sunset, and with balloon and rocket-borne externally occulted coronagraphs, it appears that ground-based K-coronameter measurements to a distance of 1.5 to 2.0 $R_\odot$ are sufficient to detect the coronal streamers. (auth)

8130 SOLAR PLASMA IRREGULARITIES AND PLASMA INSTABILITIES. Alurkar, S. K. (Instituto de Pesquisas, San Jose dos Campos, Brazil). Solar Phys.; 26: No. 1, 225-8 (Sep 1972).

Observations of interplanetary scintillation of radio sources were used to estimate the size of plasma irregularities down to a distance of about 6 $R_\odot$ from the Sun. This was compared with the values of the ion gyro-radius estimated for a range of distance from 1 AU to about 6 $R_\odot$ from the Sun. The results of the calculations are discussed in the context of the hypothesis of plasma instability which is invoked to interpret the observations of the scattering of radio waves in the solar corona and of interplanetary scintillations. (auth)

8131 OBSERVATION OF SOLAR PARTICLE FLUXES OVER EXTENDED SOLAR LONGITUDES. Bukata, R. P.; Rao, U. R.; McCracken, K. G.; Keath, E. P. (Univ. of Texas, Dallas). Solar Phys.; 26: No. 1, 229-40(Sep 1972).

Detailed particle observations from various Pioneer Spacecrafts located at different heliolongitudes during the complex solar flare events of March 30–April 10, 1969 were utilized to investigate the energy dependence of azimuthal gradients of cosmic-ray particles and its effect on the decay of the flare intensity. For an observer located to the east of the centroid of the population, the azimuthal corotation term and the convection term will be additive, resulting in a short decay time constant. An observer located to the west of the centroid of the population will experience a much longer decay time constant, the corotation term partially or completely compensating the loss of particles due to convection. At very low energies, the azimuthal corotation term may even be more than the convection term, thus resulting in a rise in intensity instead of decay during late in the event. Using the relationship showing the dependence of the spectral exponent of the cosmic-ray flux late in a flare event on the azimuth from the centroid of the population given by McCracken et al., the energy dependence of the decay time constant and the cross-over energy at which the azimuthal gradient term equals the convection term are investigated. The experimental observations are shown to be generally consistent with the theoretical picture, confirming the importance of convection and the azimuthal gradient in determining the decay profile of flare events. (auth)

8132 SOLAR ACTIVITY AND THE VARIATIONS OF THE GEOMAGNETIC K_p-INDEX. I. PHOTOSPHERIC ACTIVITY. Mariska, J. T.; Oster, Ludwig (Univ. of Colorado, Boulder). Solar Phys.; 26: No. 1, 241-9(Sep 1972).

A careful correlation analysis was made between various types of solar activity as observed at photospheric levels and the daily variations of the geomagnetic K_p-index which, in turn, is a measure of the solar-wind speed. It was found that in no case did a significant enough correlation exist to pin-point a physical relation between some aspect of photospheric activity and the solar-wind speed. It is concluded that the physical processes that do determine the wind speed occur at coronal heights. (auth)

8133 THALLIUM IN THE SOLAR ATMOSPHERE. Lambert, D. L. (Univ. of Texas, Austin); Mallia, E. A.; Smith, G. Solar Phys.; 26: No. 1, 250-6(Sep 1972).

Umbral spectra are shown to contain an absorption feature

attributable to the Tl I transition $6p^2P^0_{\frac{1}{2}}-7s^2S_{\frac{1}{2}}$ at 5350 Å. Analysis of the umbral spectrum suggests a solar abundance in the $0.72 < \log N(Tl)T < 1.10$ on the standard scale $\log N(H) = 12.00$. Unidentified blends limit the accuracy of the abundance determination. (auth)

8134 NEUTRINO ARCHAEOLOGY. THE SIMULATION OF DOUBLE BETA-DECAY BY SOLAR NEUTRINOS. Bozoki, G.; Lande, K. (Univ. of Pennsylvania, Philadelphia). Nuovo Cim.; 12B: No. 1, 65-71(11 Nov 1972).

The possibility is suggested that neutrinos from solar thermonuclear reactions can induce apparent double beta-decay. The rate $A^z \rightarrow A^{z+2}$ is computed for a group of likely target isotopes. Apparent double positron decay induced by antineutrinos emitted by the radioactive component of the Earth is also evaluated. (auth)

8135 COEFFICIENT OF ADHESION OF ELECTRONS TO NEUTRAL PARTICLES OF METEORIC MATERIAL. Bibarsov, R. Sh.; Babadzhanov, P. B. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 15: No. 6, 29-31(1972). (In Russian).

Photographic and radiolocation observations on a given meteor were used to determine the coefficient of adhesion of electrons to neutral particles of the meteoric material and the predominant chemical composition of the meteor body. Two Leonid (1966) and three Perseid (1967) specimens were identified as stony meteorites. (K.S.W.)

8136 SPECTROMETRY OF THE COMET TAGO–SATO–KOSAKA, 1969 IX. Dobrovol'skii, O. V.; Mamadov, O.; Chernova, G. P. (Inst. of Astrophysics, Tashkent). Dokl. Akad. Nauk Tadzh. SSR; 15: No. 6, 18-21(1972). (In Russian).

The free radicals CN, CH, C_3, and C_2 were observed in a slit spectrum of the comet Tago–Sato–Kosaka 1969 IX. The change in the ratios of the integral intensities of these radiations with an increase in the heliocentric distance was not smooth but possessed an abrupt character which was apparently associated with active processes taking place in the comet. At the time of observation the comet was redder than the Sun. (K.S.W.)

8137 ANALYSIS OF THE EXTREME-ULTRAVIOLET QUIET SOLAR SPECTRUM. Dupree, A. K. (Harvard Coll., Cambridge, MA). Astrophys. J.; 178: No. 2, 527-41(1 Dec 1972).

The extreme-ultraviolet spectrum (λ304 to 1400 Å) from a region 1′ square at the quiet center of the solar disk was analyzed to obtain emission measures of the quiet chromosphere, transition region, and corona, and simultaneously to determine the relative abundances of the elements carbon, nitrogen, oxygen, neon, sodium, magnesium, aluminum, silicon, sulfur, and iron. The values agreed well with photospheric abundances. By using a new method of analysis, it was demonstrated that the quantity $(N_eT_e)^2(T^{\frac{1}{2}}dT/dh)^{-1}$ was constant to within a factor of 2 over the temperature range 1.2×10^5 to 1.6×10^6 °K. If the electron pressure was assumed constant through this range, then the heat flux conducted through the transition zone was also constant to within a factor of 2. A one-dimensional temperature model that was consistent with the observed intensities was constructed from the results. This model has an isothermal corona at a temperature of 1.6×10^6 °K and a constant conductive flux of 1.25×10^6 ergs cm^{-2} s^{-1} in the chromosphere–corona transition region. Some aspects of line excitation and formation are also discussed. (auth)

8138 INTERACTION CONTRIBUTIONS TO THE SOLAR PROTON–PROTON REACTION. Gari, M.; Huffman, A. H. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Astrophys. J.; 178: No. 2, 543-9(1 Dec 1972).

Interaction contributions (meson-exchange effects) to the solar p-p reaction were evaluated using the low-energy theorem results. A correction to the cross-section S_{11} of approximately 9% is found. (auth)

8139 ABSOLUTE RAMAN SCATTERING CROSS-SECTION OF MOLECULAR HYDROGEN. Carlson, R. W.; Fenner, W. R. (Univ. of Southern California, Los Angeles). Astrophys. J.; 178: No. 2, 551-6(1 Dec 1972).

The absolute Raman scattering cross section of H_2 for the pure rotational lines and the Q-branch of the vibrational transition was determined at the incident wavelengths 4800 and 5145 Å. The absolute values were obtained by comparison to another Raman line, the 992 cm^{-1} line of benzene, for which the cross section had been determined by Kato and Takuma through absolute radiometric methods. Using the measured cross sections which are estimated to be accurate to ±20 percent, the molecular polarizabilities γ_{00} and α_{01} were determined to be $\gamma_{00} = 0.362 \times 10^{-24}$ cm^2 and $\alpha_{01} = 0.137 \times 10^{-24}$ cm^2. The average cross section for the Q-branch was ~1.4% of the calculated Rayleigh cross section while, at 294°K, the total rotational Raman cross section for H_2 gas was ~2.7% of the calculated Rayleigh cross section. (auth)

8140 EXTREME-ULTRAVIOLET EMISSION FROM SOLAR PROMINENCES. Noyes, R. W. (Smithsonian Astrophysical Observatory, Cambridge, MA); Dupree, A. K.; Huber, M. C. E.; (and others). Astrophys. J.; 178: No. 2, 515-25(1 Dec 1972).

Spectra and spectroheliograms of prominences were obtained at wavelengths 300 Å < λ < 1400 Å from instruments aboard the OSO 4 and OSO 6 spacecraft. Quiescent prominences appear in emission above the limb for all strong lines formed at temperatures below 3×10^5 °K, but not at higher temperatures. The gas pressure in the 10^5 °K transition zone around prominences is approximately equal to that in the cooler (6500°K) central regions. The temperature and the hydrogen ground-state departure coefficient in the central regions are determined from the Lyman-continuum spectrum. Prominences on the disk (filaments) are visible in absorption in many lines, especially those at wavelengths below the hydrogen Lyman limit at 912 Å. The fractional absorption, averaged over the spectrometer aperture, decreases regularly with increasing temperature of line formation. The hydrogen Lα and Lβ lines show only slight absorption relative to chromospheric lines lying on top of the Lyman continuum. (auth)

8141 ULTRAVIOLET STELLAR FLUXES. III. IMPORTANCE OF H_2 LYMAN-BAND ABSORPTION IN THE SUN AND OTHER STARS. Tarafdar, S. P.; Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Astrophys. J.; 178: No. 2, 509-13(1 Dec 1972).

Lyman-band absorption of H_2, when compared with the combined opacity of H, C I, Mg I, and Si I, has been found to contribute significantly to the total opacity in the range 912 to 1900 Å in the solar atmosphere. Inclusion of Lyman-band absorption in the solar model may reduce chromospheric temperature from that given by Gingerich et al. and improve agreement between observed and calculated extreme-ultraviolet and microwave intensities. The Lyman-band absorption may also be important in stars as hot as A0. (auth)

8142 OBSERVATIONS OF RUNNING PENUMBRAL WAVES. Zirin, Harold; Stein, Alan (Carnegie Inst. of Washington, D. C. Astrophys. J.; 178: No. 2, L85-7(1 Dec 1972).

Quiet sunspots with well-developed penumbrae show running intensity waves with period running around 300 seconds. The waves appear connected with umbral flashes of exactly half the period. Waves are concentric, regular, with velocity constant around 10 km s^{-1}. They are probably sound waves and show intensity fluctuation in Hα centerline or wing of 10 to 20%. The energy is tiny compared to the heat deficit of the umbra. (auth)

Galaxies

Refer also to abstracts 8007, 8045, 8065, 8163, 8167, and 8168.

8143 (AD-745314) SPECTROPHOTOMETRY OF GALACTIC NEBULAE MORPHOLOGICAL PROPERTIES OF THE ORION NEBULA CONCERNING THE 'DUST LANES' IN H_2 REGIONS. Wurm, K. A. (Hamburger Sternwarte (West Germany)). 30 Jun 1971. Contract F61052-68-C-0058. 15p. (AFCRL-72-270). NTIS.

The report discusses the following: The different more recent researches of the continuous emission in the Orion Nebula; surface features clearly typical for the scattered continuum, others clearly typical for the Balmer line emission; discussion of the observational results; and a typical example of a "dust lane" in H II regions. (GRA)

8144 THEORETICAL GAS CONTENTS OF GALAXIES. Hills, J. G. (Univ. of Michigan, Ann Arbor). Astrophys. Lett.; 12: No. 3, 153-4(Nov 1972).

The observation that the neutral gas contents of spiral or irregular galaxies of a given morphological class are directly proportional to their luminosity is shown to follow from energy conservation if their gas was cumulated from the mass shed by evolving stars. The increase in the constant of proportionality in this relation from morphological class S0 to I is shown quantitatively to reflect a systematic change in these galaxies of that part of their stellar populations primarily responsible for their integrated luminosities. (auth)

8145 GRAVITATIONAL INSTABILITY OF TWO STREAMS. Sengar, R. S.; Khare, H. C. (Allahabad Univ., India). Ann. Soc. Sci. Brux, Ser. I; 86: No. 3, 283-9(1972).

Gravitational instability of an interface separating two semi-

infinite homogeneous streams of uniform densities ρ_1 and ρ_2 is investigated. The streams move along the interface with uniform velocities U_1 and U_2. Dispersion relation is obtained in the general case and critical wave numbers and Jeans' growth rate are obtained in various cases of physical interest including the case of a single homogeneous medium. The effect of slipping motion on Jeans' criterion is also discussed. (auth)

8146 OBSERVATIONS OF NGC 4319 AND MARKARIAN 205. Ford, H. C.; Epps, H. W. (Univ. of California, Los Angeles). Astrophys. Lett.; 12: No. 3, 139-41(Nov 1972).

A narrow-band, sky-limited, Hα photograph taken at the prime focus of the Lick 120-in. telescope during excellent seeing does not show a connection between NGC 4319, whose redshift is 0.006, and Markarian 205, whose redshift is 0.070. A wide-band, sky-limited, green-light photograph taken during good seeing does not show a connection at a photographic density that can be considered significant. It is suggested that Markarian 205 is an N-type galaxy at cosmological distance. (auth)

8147 LIMITS ON Hα EMISSION IN NGC 4319 ASSOCIATED WITH MARKARIAN 205. Adams, T. F. (Yerkes Observatory, Williams Bay, WI); Weymann, R. J. Astrophys. Lett.; 12: No. 3, 143-6(Nov 1972).

Photographic plates of Markarian 205 taken through a narrow-band filter centered on Hα at the redshift of the nearby galaxy NGC 4319 fail to reveal the "connection" reported by Arp. The observational limits on the emission measure are used to rule out a model in which Markarian 205 was ejected in the plane of NGC 4319. Other models in which Markarian 205 is not in the plane of NGC 4319, but still at the same distance, cannot be rejected without a substantial improvement in the observations. (auth)

8148 MOLECULAR CLOUDS IN THE GALACTIC CENTER REGION: CARBON MONOXIDE OBSERVATIONS AT 2.6 MILLIMETERS. Solomon, P. M. (Univ. of Minnesota, Minneapolis); Scoville, N. Z.; Jefferts, K. B.; Penzias, A. A.; Wilson, R. W. Astrophys. J.; 178: No. 1, 125-30(15 Nov 1972).

A preliminary CO emission line survey covering a strip at b = −2′ from l = 359.7° to l = 2.8° is presented which shows a continuous band of emission connecting the region between Sgr A and Sgr B. A high-resolution map of the Sgr A cloud near the galactic center shows that there are at least two clouds centered within 3′ of each other with a velocity difference of 35 km s^{-1}. Measurement of the $^{13}C^{16}O$ and $^{12}C^{18}O$ emission indicates isotopic abundances similar to those of the solar system. (auth)

8149 LATITUDE EXTENT OF DIFFUSE IONIZATION IN THE GALAXY. Gordon, M. A. (National Radio Astronomy Observatory, Green Bank, WV); Brown, R. L.; Gottesman, S. T. Astrophys. J.; 178: No. 1, 119-24(15 Nov 1972).

Observations of radio recombination lines (H157α) at λ18 cm, from regions free of discrete radio sources, show the line emission to be confined to within 0.5° of the galactic equator at $l^{II} = 33°$. This angle implies the largest values of the measured physical parameter $\langle N_e N_{H\,II}/T_e^{1.5}\rangle$ to be entirely within 70 pc of the plane. Such a distribution appears to be consistent with that expected from a thermal gas in hydrostatic pressure equilibrium with a temperature of approximately 3600°K. (auth)

8150 COMPACT CENTRAL REGION OF THE GALAXY NGC 1614. Ulrich, M. H. (Univ. of Texas, Austin). Astrophys. J.; 178: No. 1, 113-18(15 Nov 1972).

Spectrographic investigations of the peculiar galaxy NGC 1614 (or II Zw 15) with a dispersion of 28 Å mm^{-1}, and scales perpendicular to the dispersion of 24″ and 13.5″ mm^{-1}, have given the following results: (a) The inclination of the emission lines on spectra taken in P.A. 0° and 30° is interpreted as due to rotation of the galaxy and gives a mass $M \simeq 1.5 \times 10^9\ M_\odot$ for the central region, 570 pc in radius. (b) A wing of Hα extending 10 Å to the blue is interpreted as evidence for an outflow of ionized gas from the nucleus of the galaxy and toward the observer with a radial velocity up to 450 km s^{-1} with respect to the nucleus. (auth)

8151 FORMATION OF DIATOMIC MOLECULES IN INTERSTELLAR CLOUDS. Solomon, P. M. (Columbia Univ., NY); Klemperer, William. Astrophys. J.; 178: No. 2, 389-421(1 Dec 1972).

The rates of a number of homogeneous gas-phase chemical reactions likely to occur in clouds composed primarily of atomic hydrogen, with $10 < n_H < 1000$, are estimated. It is shown that the primary mechanism for producing diatomic molecules from atoms is the radiative association of C + H and C^+ + H yielding CH and CH^+. Dielectronic recombination of CH^+ is important in producing CH, destroying CH^+ and increasing the ratio CH/CH^+ relative to C/C^+. Other important processes, including exothermic chemical exchange and charge-exchange reactions, lead to the production of C_2, CN, and CO, but not NO, N_2, or O_2. The steady-state abundance of electrons, atoms, ions, and diatomic molecules composed of H, C, N, and O is determined as a function of the H density, the kinetic temperature, and the ultraviolet optical depth, which governs the photodissociation and ionization rates. A comparison of the theory with optical observations of the interstellar medium, particularly the well-studied features in the ζ Oph spectrum, shows good qualitative and quantitative agreement. A molecular composition dominated by carbon monoxide and with a variety of diatomic species can be established in the interstellar medium by pure gas-phase reactions. (auth)

8152 IC 3576: AN UNUSUAL SPIRAL GALAXY IN VIRGO. Margon, Bruce (Univ. of California, Berkeley); Spinrad, Hyron; Heiles, Carl; (and others). Astrophys. J.; 178: No. 2, L77-80 (1 Dec 1972).

A weak, soft x-ray source in Virgo was detected. If the positional information from the experiment is combined with that for the Uhuru source 2U 1231 + 7, the resulting error box of size 0.4 square degrees is centered on IC 3576, an unusual spiral galaxy. Several direct photographs of this galaxy were obtained. Neutral hydrogen emission was observed at 21 cm from IC 3576, and upper limits on emission at 5, 1.4, and 0.43 GHz were obtained The galaxy has an extraordinarily large ratio of H I to optical luminosity. Regardless of the identification of the x-ray source, the optical and radio data are difficult to reconcile. (auth)

Cosmology

Refer also to abstracts 8453, 8454, 8456, and 8457.

8153 (AD–743267) OBSERVATIONS OF THE SOFT X-RAY BACKGROUND. Davidsen, A.; Shulman, S.; Fritz, G.; Meekins, J. F.; Henry, R. C. (Hulbert (E. O.) Center for Space Research, Washington, D. C.). Apr 1972. 47p. NTIS.

Observations of the diffuse x-ray background over a hemisphere of the sky in the galactic anticenter direction provide clear evidence for an excess intensity below 1 keV in all directions. The correlation of this low-energy flux with galactic latitude and with hydrogen column density implies that the radiation originates partially within and partially outside the absorbing layers of the Galaxy. (auth) (GRA)

8154 COSMOLOGICAL INFERENCES FROM THE ANGULAR DIAMETERS OF QUASARS. Reinhardt, Michael (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett.; 12: No. 3, 135-8(Nov 1972).

The distribution function of linear diameters of quasars is investigated for sources whose largest angular separation is not smaller than 7 arc sec in Miley's compilation. The distribution function is consistent with the assumption of no cosmological evolution in low-density Friedmann universes. The existence of a class of objects with a well-defined linear diameter between 0.33 and 0.43 Mpc is indicated. (auth)

8155 PRIMORDIAL TURBULENCE AND THE FORMATION OF GALAXIES. Silk, Joseph; Ames, Susan (Univ. of California, Berkeley). Astrophys. J.; 178: No. 1, 77-93(15 Nov 1972).

The density perturbations that would arise on the scale of galaxies through incompressible turbulence were calculated using a post-Newtonian approximation and retaining terms which are nonlinear in the velocity. During the era when the radiation energy density is greater than the matter energy density, this nonlinear mode grows as $t^{\frac{1}{2}}$; and when the radiation density drops below that of the matter, after the epoch z_* at which the matter and radiation mass densities are equal, it continues to grow but less rapidly, as $t^{\frac{2}{3}}$. The initial turbulence is dissipated by viscous decay prior to recombination and by condensation of the surviving modes of strong turbulence immediately after decoupling. However, on galactic mass-scales, small-amplitude density fluctuations due to interactions of the turbulent eddies are frozen out of the turbulent flow at epochs following z_*. If an initial turbulent velocity field was present with a maximum velocity $v/c \sim 10^{-2}$, then at decoupling density fluctuations of order 0.1 to 1% would be generated over galactic scales. These fluctuations may then grow into protogalaxies through gravitational instability and would not reach the nonlinear growth regime until a redshift $z < 10$. Since the calculated amplitudes are a decreasing function of mass-scale, it is a natural consequence of this theory that galaxy clusters form after galaxies. This theory can also account for the observed angular momentum of spiral galaxies. (auth)

8156 REDSHIFT–DISTANCE RELATION. III. PHOTOMETRY AND THE HUBBLE DIAGRAM FOR RADIO SOURCES AND THE

POSSIBLE TURN-ON TIME FOR QSOs. Sandage, A. (Carnegie Institution of Washington, DC). Astrophys. J.; 178: No. 1, 25-44 (15 Nov 1972).

UBV photometry is given for 59 radio galaxies, and is summarized for 103 radio and 25 radio-quiet quasars. The Hubble diagram for the radio galaxies is similar to that for first-ranked cluster galaxies, but is displaced faintward by 0.3 mag in the mean. If $H_0 = 50$ km s^{-1} Mpc^{-1}, then $\langle M_v \rangle = -22.98$ with $\sigma = 0.49$ mag for radio galaxies, and $\langle M_v \rangle = -23.26$ with $\sigma = 0.32$ mag for first-ranked cluster galaxies. Radio galaxies can be as bright as the brightest E galaxies in clusters, but their luminosity distribution is asymmetric, reaching fainter limits. If the mass-to-light ratio is 30 in visual solar units, a galaxy must have a mass greater than 10^{12} $M_\odot$ to be a strong radio source. First-ranked cluster galaxies and the brightest radio galaxies have an upper limit to their mass that is of order 10^{13} $M_\odot$. The Hubble diagram for quasars is scattered, but no quasars lie to the right (fainter) of the radio galaxy distribution. This can be understood if a quasar consists of a normal strong radio galaxy upon which a nonthermal component is superposed which has a wide intrinsic dispersion (factor of ~50) to its optical luminosity. Quasars are then at their Hubble distance. The apparent cutoff in quasar redshifts near $z = 2.8$ is examined for selection effects that could produce it artificially. If the cutoff is real, it may be the time of the birth of the first quasars, although the suggested redshift is unexpectedly small. At $z = 3$ in a $q_0 = +1$ universe, the look-back time is 89% of the Friedmann age. Assessment of the observational selection effects shows that none are positively established that would produce the cutoff artificially. Special observations to test its reality are straightforward and can be made with existing ground-based telescopes, but they have not yet been done. Previously unreported photometry for 22 quasars is listed in an appendix. (auth)

8157 REDSHIFT–DISTANCE RELATION. II. THE HUBBLE DIAGRAM AND ITS SCATTER FOR FIRST-RANKED CLUSTER GALAXIES: A FORMAL VALUE FOR q_0. Sandage, A. (Carnegie Institution of Washington, DC). Astrophys. J.; 178: No. 1, 1-24 (15 Nov 1972).

The Hubble diagram for first-ranked cluster galaxies is discussed on the basis of new photoelectric measurements of 41 clusters. Additional data by Westerlund and Wall and by Peterson, reduced by the same corrections, increase the sample to 84 clusters. The diagram has small scatter about a line of slope 5. Analysis of the scatter gives upper limits to the dispersions in redshift and in apparent magnitude, respectively. Treated as redshift residuals, the data show $\Delta \log z$ to be independent of z; and because of this, most of the scatter must be due to residuals in magnitude. A limit of $\sigma(\Delta cz) \simeq 100$ km s^{-1} for the distribution of random velocities of cluster centers in the present sample can be put from the analysis. From the magnitude residuals, the dispersion in absolute luminosities of first-ranked galaxies is $\sigma(\Delta M_V) = 0.25$ mag. For such galaxies in the present sample, the absolute magnitudes are independent of richness of the parent cluster over a richness range $5 \lesssim N \lesssim 500$. There is no evidence for intergalactic absorption for galaxies in the present sample, either patchy at the $\sigma = 0.25$ mag level, or general and selective at the $\sigma[E(B-V)] \simeq 0.05$ mag level. If a strictly homogeneous Friedmann model universe is adopted, the deceleration parameter is calculated to be $q_0 = 0.96 \pm \sim 0.4$ (p.e.). To reduce this formal value to $q_0 = 0$ requires a luminosity evolution at the rate $dM/dt = 1.09\ (1+z) H_0$ mag yr^{-1}, in the sense that E galaxies were brighter in the past. With $q_0 = +1$ and $H_0 = 50$ km s^{-1} Mpc^{-1}, the time to the Friedmann singularity is 11×10^9 years, which agrees with the age of globular clusters in the Galaxy. (auth)

8158 FOUNDATIONS OF GENERAL RELATIVISTIC HIGH-PRESSURE ELASTICITY THEORY. Carter, B.; Quintana, H. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A; 331: No. 1584, 57-83(21 Nov 1972).

A fully relativistic formulation of the concept of a perfectly elastic solid is developed with a view to application to such problems as the interaction of gravitational radiation with planetary type bodies such as the earth, and the vibrations and deformations of neutron star crusts. For applications of the former kind a low pressure Hookean idealization (i.e., a theory postulating a linear stress-strain relation) will often be sufficient. A prototype version of a relativistic Hookean theory suitable for this purpose has already been given by Rayner (1963), but it will be shown that Rayner's theory needs minor corrections in order to be strictly self consistent. For applications to neutron stars a purely Hookean theory will in any case be inadequate, and to replace it a high pressure quasi-Hookean idealization is described. This idealization includes the important special case of the perfect (i.e., isotropic) solid in which the elastic properties may be described in terms of just two (non-linear) functions of state, namely the pressure and the modulus of rigidity. The theory reduces to the familiar perfect fluid idealization in the limit when the modulus of rigidity is zero. (auth)

8159 MECHANICAL MATCHING CONDITION RELATED TO THE DETECTION LIMIT FOR GRAVITATIONAL RADIATION. Maeder, D. G. (Univ., Geneva). J. Phys., A (London); 5: No. 11, L113-18(Nov 1972).

Detector characteristics are reduced to four parameters: T_1 = period M_{sys} = total mass μ = relative transducer mass, r = mismatch ratio. Calculation of the response to a standardized gravity pulse is outlined. Mechanical and electrical signal-to-noise ratios are defined as theoretical limits for zero amplifier noise ($p_a = 0$) and zero detector temperature ($\theta = 0$), respectively. Maximum overall sensibility requires resolving time adjustments depending on r and μ, and proportional to $T_1(p_a/\theta)^{1/2}$. For any suitable μ value, matched systems ($r = 0$) approach the maximum sensibility which is shown to vary according to $T_1 M_{sys}^{1/2} (p_a\theta)^{-1/4}$, contrary to current views based on simplified arguments (auth)

8160 GENERALIZED TAUB SOLUTION. Horsky, J.; Novotny, J. (Purkyne Univ., Brno). Bull. Astron. Inst. Czech.; 23: No. 5, 266-7(1972).

Disturbances of a certain type lead to the conclusion that the mixmaster model of the Universe is identical with the Taub solution within a certain region. Under the assumption that $\Lambda > 0$ and of the corresponding general form of the metrics, a solution of the Einstein equations is presented. The two types of this solution obtained could play an interesting role in studying the generation of mass in the early stages. (auth)

8161 HAMILTONIAN COSMOLOGY. Ryan, M. Lecture Notes in Physics, Volume 13. Berlin; Springer-Verlag (1972). 178p. $5.60.

Since the initial application of Hamiltonian techniques to cosmology, the field has grown so rapidly that a review of the work that has been done, along with an explanation of work in progress, and an indication of future direction, was felt desirable. Topics discussed include ADM formalism applied to homogeneous cosmologies, Hamiltonian formalism, Hamiltonian formulation applied to more complex systems, applications to Bianchi-type universes, superspace, and quantization. (W.D.M.)

8162 RADIAL MOTION OF A SPINNING TEST BODY IN THE FIELD OF A BLACK HOLE. O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Phys. Rev., D; 6: No. 10, 3035-6 (15 Nov 1972).

The gravitational radiation emitted by a test particle falling radially into a Schwarzschild black hole was analyzed by Zerilli. The effect of assigning spin to both the test particle and the source is investigated. It is found that more (less) gravitational radiation is emitted if the spins are antiparallel (parallel). (auth)

8163 GALAXY FORMATION FROM ANNIHILATION-GENERATED SUPERSONIC TURBULENCE IN THE BARYON-SYMMETRIC BIG-BANG COSMOLOGY AND THE GAMMA-RAY BACKGROUND SPECTRUM. Stecker, F. W. (Goddard Space Flight Center, Greenbelt, MD); Puget, J. L. Astrophys. J.; 178: No. 1, 57-76(15 Nov 1972).

Following the big-bang baryon-symmetric cosmology of Omnès where an initial phase separation of matter and antimatter leads to regions of pure matter and pure antimatter containing masses of the size of galaxy clusters by a redshift which is calculated to be of the order of 500 to 600, it is shown that at these redshifts, annihilation pressure at the boundaries between the regions of matter and antimatter drives large-scale supersonic turbulence which can trigger galaxy formation. This picture is consistent with the γ-ray background observations discussed previously by Stecker, Morgan, and Bredekamp. Gravitational binding of galaxies then occurs at a redshift of ~70 at which time vortical turbulent velocities of $\sim 3 \times 10^7$ cm s^{-1} lead to angular momenta for galaxies comparable with measured values. (auth)

8164 NONLINEAR LAGRANGIAN AND COSMOLOGY. Novello, M. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notis Fis., Cent. Brasil. Pesqui. Fis.; 18: No. 23, 327-32(1972).

It is shown that the fluctuation of the gravitational field may give origin to an important effect even in regions far from the singularity. (auth)

8165 FINITE EXPANDING UNIVERSE WITH MATTER INJECTION. Gomide, F. M. (Instituto Tecnologico de Aero-

nautica, Sao Jose dos Campos, Brazil). Nuovo Cim.; 12B: No. 1, 11-19(11 Nov 1972).

A fluid homogeneous cosmological model is proposed with a Robertson–Walker metric and positive curvature. The Einstein field equations are modified through the following two assumptions: the principle of Mach in Whitrow's formulation and a new version of Hoyle's vector field. The present model affords an interpretation to the matter production process in the following terms: the matter injection into the observable Universe is due to the work done along cosmic expansion by a negative-pressure substratum and to the variation of a negative field energy. The properties of the expansion function and the vector field demand a negative cosmological constant. (auth)

8166 POSSIBILITY THAT NONGASEOUS HYDROGEN SUPPLIES THE MISSING COSMOLOGICAL MASS. Noonan, T. W. (Brockport State Coll., NY). Astrophys. J.; 178: No. 2, 317-18 (1 Dec 1972).

Considerations of intergalactic extinction and thermal equilibrium with intergalactic radiation fields indicate that intergalactic particles with radii larger than 2 mm and a temperature of order 3°K may exist in sufficient quantity to supply the missing cosmological mass. However, the vapor pressure of solid hydrogen imposes an upper limit of 1.7°K. Although there is the possibility of "asteroids" of solid hydrogen, the existence of particles of solid or liquid hydrogen must be regarded as an impossibility. (auth)

8167 LOCATION OF THE SOURCE OF WEBER'S GRAVITATIONAL EVENTS. Douglass, D. H. (Univ. of Rochester, NY); Tyson, J. A. Astrophys. J.; 178: No. 2, 341-6(1 Dec 1972).

It is found that the location of the source(s) of gravitational radiation reported by Weber depends strongly on assumptions concerning the nature of the polarization of the radiation. If a single randomly polarized source is assumed, then the possible locations are confined to four small regions of the sky at right ascension (R.A.) 5.7 ± 0.2h, 17.7 ± 0.2h and declination ± (29° ± 5), which includes the Galactic nucleus. If, on the other hand, a single source is assumed that is linearly polarized, then the possible locations consist of two oval shaped bands centered about the points R. A. 5.7h, 17.7h, and 0° decl. (auth)

8168 COSMOLOGICAL IMPLICATIONS OF COUNTS OF GALAXIES. Rowan-Robinson, M. (Queen Mary Coll., London). Astrophys. J.; 178: No. 2, L81-3(1 Dec 1972).

An error in a recent paper by Sandage, Tammann, and Hardy, while in no way invalidating their argument against hierarchical models of the Universe, does admit the possibility of a strong evolutionary effect in the interpretation of counts of galaxies. (auth)

Planetary Phenomena

Refer also to abstracts 8101 and 8158.

8169 URANIUM–LEAD CHRONOLOGY OF CHONDRITIC METEORITES. Gale, N. H. (Oxford Univ.); Arden, J.; Hutchison, R. Nature (London) Phys. Sci.; 240: No. 99, 56-7(20 Nov 1972).

Modern radiometric estimates of the age of the Earth are based on the isotopic composition of Pb in the triolite phase of iron meteorites and in bulk samples of chondritic meteorites, but it is not always appreciated that the accuracy of the meteorite Pb–Pb isochron is very poorly established. It has been shown that for most measured chondrites there is insufficient U and Th to explain the observed development of radiogenic Pb. Considerable variations in U and Pb concentrations are observed in different gram sized fragments of the same meteorite, and fission track studies show that changes in U concentration by factors of 10^5 are observed over distances of $\sim 10^{-2}$ cm. Analytical methods have also been suspect. The uncertainties of meteorite U–Pb data prompted the authors to apply modern advances in analytical techniques to re-examine the problem. In this connection the heterogeneous distribution of U and Pb presents a severe sampling problem. Also specially clean laboratories are required, and ultra pure reagents must be employed. A new electrochemical method for the separation of Pb at trace levels has been developed, and for the separation of U a column chromatographic method has been adopted based on a tributyl phosphate on a PTFE medium. Data were accumulated on olivine-hypersthene chondrites and an amphoterite, and the superior accuracy of the measurements was clearly demonstrated; it was also confirmed that there is insufficient U to support the Pb isotopic composition. From this work it follows that the whole of the classical interpretation of the meteorite Pb isotope data is in doubt, together with radiometric estimates of the age of the Earth. (UK)

8170 DECAMETRE-WAVE RADIATION FROM JUPITER AND SOLAR ACTIVITY. Barrow, C. H. (Univ. of the West Indies, Kingston, Jamaica). Planet. Space Sci.; 20: No. 12, 2051-6(Dec 1972).

The problem of a possible short term correlation between Jupiter's decameter-wave radio emission and solar activity is re-examined and the complicating factors are discussed. Developing the approach of Sastry (Planet. Space, Sci.; 16: 1147 (1968)), Jupiter events are used as epochs and the Chree analysis method is applied to data taken from 1961 to 1968. The data are separated into two parts, before and after each opposition, and this is shown to provide an additional test for correlation. The results are found to be consistent with the idea that at least some of the Jupiter radiation may be stimulated by solar particles having radial velocities in the range 350 to 700 km/sec travelling outward as far as the orbit of Jupiter. (auth)

8171 JUPITER TRAPPED RADIATION BELTS. Beck, A. J. JPL Quart. Tech. Rev.; 1: No. 4, 78-88(Jan 1972).

Previously developed models for trapped electron radiation belts and trapped proton radiation belts in the Jovian magnetosphere are described. The spatial distribution of flux and the L-shell dependence of the characteristic energy are displayed for both models. Based on these models, the fluence accumulated by a Jupiter flyby spacecraft is given in terms of the equivalent 3-MeV fluence for electrons and the equivalent 20-MeV proton fluence for protons. Finally, some impacts of these fluences on outer-planet missions are described. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 8106 and 8198.

8172 (AD-742523) DNA PROJECT 617 RADAR: FIRST AURORAL-ZONE RESULTS. Final Report, July-November 1971. Baron, M. J.; Watt, T. M.; Rino, C. L.; Petriceks, J. (Stanford Research Inst., Menlo Park, Calif.). Dec 1971. Contract DASA-01-70-C-0124. 159p. (DNA-2826-F). NTIS.

The ionospheric studies performed between July and November 1971 using the DNA Project 617 incoherent-scatter radar are described. The diurnal and (to some extent) seasonal behavior of the auroral ionosphere has been studied using 24-hour continuous data. Measurements on the auroral E layer have shown densities as high as 1.8×10^{12} el/cm^3. Other characteristics of the auroral E layer that have been studied include its thickness, electron-density gradient, production rate, and recombination coefficient. Velocity measurements have been made that show the normal as well as disturbed behavior. Ionization drift velocities as high as 200 m/s have been measured. The latitudinal distribution of ionization over several degrees of magnetic latitude has been observed and on several occasions the position of the northern boundary of the plasma trough has been determined. Also described are cooperative experiments in progress with satellites, the Homer multifrequency auroral radar, and various auroral-zone geophysical measurement programs. (GRA) (auth)

8173 (AD-742776) DIRECTION FINDING ON WHISTLERS AND RELATED VLF SIGNALS. Cousins, M. D. (Stanford Univ., Calif. Stanford Electronics Labs.). May 1972. Contract N00014-67-A-0112-0012. 201p. (SU-SEL-72-13). NTIS.

The direction of arrival of whistlers and related vlf signals was measured by a new technique. This technique consists of applying an already-existing theory (the "four-parameter method") to data collected by a novel measurement procedure. Measurements of signals induced in orthogonal loop antennas and a vertical monopole located at a single site provide the necessary data. The four-parameter theory relates the loop and vertical voltages, taking into account both amplitudes and phases so that polarization error may be eliminated. The technique can be shown equal or superior in accuracy to any other vlf direction-finding scheme in current use, such as the standard crossed-loops-and-goniometer technique. (GRA) (auth)

8174 GEOMAGNETIC INDICES. Rostoker, Gordon (Univ. of Alberta, Edmonton). Rev. Geophys. Space Phys.; 10: No. 4, 935-50(Nov 1972).

The definition and method of derivation of the indices of geomagnetic activity that are most commonly used are reviewed. The first part of the review presents the methods of derivation of Kp, ap, AE, and Dst; the second part involves a discussion of the strengths and weaknesses of each index. It is shown that the distribution of magnetic observatories whose data are used in the production of the indices strongly influences the quantitative reliability of the indices in varying degrees. Furthermore, it is found that, in general, indices are only capable of defining the lower limit of geomagnetic activity at any given time. It is concluded that indices should only be used in statistical studies of solar-terrestrial interactions; their use in the study of individual events is generally not advisable. (22 references). (auth)

8175 BOMBARDMENT OF THE POLAR-CAP IONOSPHERE BY SOLAR COSMIC RAYS. Zmuda, A. J.; Potemra, T. A. (Johns Hopkins Univ., Silver Spring, MD). Rev. Geophys. Space Phys.; 10: No. 4, 981-91(Nov 1972).

Solar flares often produce bursts of energetic particles (mainly protons but also heavier nuclei and electrons). Protons from these flares with energies greater than about 0.8 MeV are of interest because they enter the Earth's atmosphere at polar latitudes and produce ionization below 90-km altitude at a rate that far exceeds the ionization rate due to normal solar and galactic sources. This increased ionization produces many interesting ionospheric effects. Comparison of ion and electron concentration profiles in the lower ionosphere (specifically in the D region) with inferences drawn from both ground-based radio data and satellite particle data lead to the conclusion that the ion chemistry at such times is much simpler than during undisturbed times. The diverse methods seem to be compatible in defining major characteristics and reactions of the D region during periods when it is bombarded by solar-flare protons. Thus these events provide the framework for a detailed investigation of D-region chemical processes. (32 references). (auth)

8176 EQUATORWARD SHIFT OF THE POLAR F-LAYER IRREGULARITY ZONE AS A FUNCTION OF THE Kp INDEX. Pike, C. P. (Air Force Cambridge Research Labs., Bedford, MA). J. Geophys. Res.; 77: No. 34, 6911-15(1 Dec 1972).

Vertical incidence ionograms, recorded in 1968, 1969, and 1970 on the AFCRL flying ionospheric laboratory, have been used to study the polar F-layer irregularity zone (Fliz) in the geomagnetic day sector. The Fliz has been shown to be most probably caused by precipitation of particles through the polar cusp. A latitudinal sequence of ionograms is presented to demonstrate the typical abrupt transition, which occurs in less than 1° of latitude, from a "normal" midlatitude F-layer reflection (that is, a reflection that shows both O and X components and stratification into F1 and F2 layer) to the very irregular and diffuse reflections characteristic of the Fliz. This abrupt transition, which marks the equatorward boundary of the Fliz, occurs on all 30 flights through the geomagnetic day sector. A dependence of the equatorward boundary of the Fliz on corrected geomagnetic (CG) local time and on Kp is shown. In the geomagnetic noon sector the boundary is at 78.75° for Kp = 0o and moves equatorward by about 1.3° per unit increase of Kp. The boundary displays a slight asymmetry about the geomagnetic noon meridian. These dependences of the equatorward boundary of the Fliz may reflect similar dependences of the equatorward boundary of the polar cusp. (auth)

8177 SOLAR ELECTRONS AND ALPHA PARTICLES DURING POLAR-CAP ABSORPTION EVENTS. Potemra, T. A.; Zmuda, A. J. (John Hopkins Univ., Silver Spring, MD). J. Geophys. Res.; 77: No. 34, 6916-21(1 Dec 1972).

During solar-proton or polar-cap absorption events the Sun sometimes emits electrons and α particles with sufficient energy, >30 keV and >3.2 MeV, respectively, to produce ionization enhancements below 90-km altitude, where solar protons with E > 0.8 MeV also produce ionization. Some characteristics of solar electrons and α particles are reviewed, and some assessments are made concerning the importance of these particles for D-region enhancements at times when solar protons are also present. Calculations for some ionospheric effects are made with the D-region model developed by Potemra et al. (1970). Events of March 24, 1966; September 2, 1966; and April 13, 1969 were studied in detail. (40 references). (J.C.W.)

8178 TECHNIQUE FOR MAKING DISPERSION RELATION MEASUREMENTS OF ELECTROSTATIC WAVES. Kelley, M. C.; Mozer, F. S. (Univ. of California, Berkeley). J. Geophys. Res.; 77: No. 34, 6900-3(1 Dec 1972).

An experimental technique is described for determining the real part of the dispersion relation for electrostatic waves by means of simultaneous measurements of the fluctuating electric field and the fluctuating plasma density as a function of frequency. Plasma density as a function of frequency. Plasma density fluctuations can be measured by a modified Langmuir probe that is biased at a fixed potential with respect to the plasma. The ratio of the ac current collected by the electrode to the dc current determines the relative fluctuation of the plasma density. If the probe is swept in voltage periodically, the magnitude of the dc current collected in the fixed bias mode of operation can be compared with the swept response to determine the plasma density, to verify the detector operation, and to measure the electron temperature. As an example of simultaneous measurements of density and potential fluctuations, data are presented and analyzed from an auroral-zone rocket flight. (J.C.W.)

8179 INDUCED ENHANCEMENT OF THE PLASMA LINE IN THE BACKSCATTER SPECTRUM BY IONOSPHERE HEATING. Harker, K. J. (Stanford Univ., CA). J. Geophys. Res.; 77: No. 34, 6904-6(1 Dec 1972).

Recent results from ionospheric modification experiments at the Arecibo Ionospheric Observatory show an enhanced plasma line temperature of approximately 4000°K due to excitation of the ion acoustic parametric instability. Recent theories on the saturation spectrum of the plasma waves excited in this experiment predict that the bulk of the wave energy is associated with waves propagating in a very narrow angular cone centered on the geomagnetic field. The intensity of the plasma waves responsible for the scattering that are propagating parallel to the probing radar beam, i.e., at 40° to the geomagnetic field, is weaker than the intensity of the parallel propagating plasma waves by orders of magnitude. It is shown that the intensity is still sufficient to account for the experimental results. (auth)

8180 DISTINCTION BETWEEN THE AURORAL ELECTROJET AND PARTIAL RING-CURRENT SYSTEMS. Crooker, N. U.

(Univ. of California, Los Angeles); McPherron, R. L. J. Geophys. Res.; 77: No. 34, 6886-9(1 Dec 1972).

A new analysis is made to support the suggestion that separate current systems exist between the auroral electrojet and partial ring-current systems. It is shown that observations of auroral positive and low-latitude negative bays are consistent with two separate current systems. That the asymmetry in the low-latitude disturbance field is not due solely to equivalent return currents from the auroral electrojets was suggested by several authors. Crooker (J. Geophys. Res., 77: 773(1972)) has shown that the orientation of the maximum depression in the low-latitude field during stormy periods shifts systematically from late evening toward earlier local time when the AE index increases. That this shift is due to the activation of an additional current system rather than a spreading or a change in total orientation of the existing current system is demonstrated when the low-latitude disturbance field is plotted on contour maps of UT versus LT. A comparison was made of the contour map presented to the previous low-latitude study by Crooker. There are two current systems consistent with the characteristics of the low-latitude asymmetry presented of a partial ring-current system of the Cummings type, (J. Geophys. Res., 71: 4495(1966)). (25 references). (J.C.W.)

8181 BEHAVIOR OF AURORA IN GERMANY, 1880–1964. Schroeder, W. (Geophysikalische Station, Bremen). J. Geophys. Res.; 77: No. 34, 6890-2(1 Dec 1972).

The study of German auroral observations (Φ = 55 to 50°N) for 1880 to 1964 shows the spring and fall maximums for the auroral activity. In Germany, only a few auroras were seen during quiet geomagnetic activity. The great displays (e.g., March 31, 1960) are always associated with maximal geomagnetic activity. These great auroras show enhancement in brightness and form with an increase in geomagnetic activity. Moreover, a table showing the frequency of auroras per year in Germany for 1880–1964 (total: 376 items) is presented. Dandekar (J. Atmos. Terr. Phys., 34: 127(1972) has published a study on auroral activity in midlatitudes. Some comparisons are made here with earlier reports by Barbier [1958] and Chapman [1957] by presenting results of long-term German observations as an example of auroral activity in mid-latitudes. (auth)

8182 ANOMALOUS ABSORPTION OF RADIO WAVES BY ELECTROJET IRREGULARITIES. Sen, Abhijit; Kaw, Predhiman (Physical Research Lab., Ahmedabad, India). J. Geophys. Res.; 77: No. 34, 6875-80(1 Dec 1972).

The enhanced absorption of radio waves (with a frequency close to the upper hybrid frequency) in the equatorial electrojet by resonant coupling to electrojet irregularities and damped upper hybrid modes is investigated. It is found that, under normal ionospheric conditions, the absorption coefficient for such radio waves may be increased by a factor of as large as 100. (26 references). (auth)

8183 MATHEMATICAL MODEL OF THE POLAR WIND. Strobel, D. F.; Weber, E. J. (Kitt Peak National Observatory, Tucson, AZ). J. Geophys. Res.; 77: No. 34, 6864-9(1 Dec 1972).

The singularities and critical points of the polar-wind equations in the hydrodynamic model of Banks and Holzer are discussed. They are shown to be functions of the relative ion composition and the ratios of the electron to ion temperatures, and can be described in terms of a "reduced" Mach number. As a result of these singularities, polar-wind flows are restricted to O^+ velocities on the order of 50 m sec^{-1} near the critical point. (auth)

8184 DYE-LASER OBSERVATIONS OF THE NIGHTTIME ATOMIC SODIUM LAYER. Hake, R. D. Jr.; Arnold, D. E.; Jackson, D. W.; (and others) (Stanford Research Inst., Menlo Park, CA). J. Geophys. Res.; 77: No. 34, 6839-48(1 Dec 1972).

Observations of the free atomic sodium layer near 90 km were made as part of performance tests on a tunable dye-laser radar. Altitude profiles of the layer obtained during parts of four nights in the fall of 1971 are consistent with those obtained by other groups but show two interesting additional features. The first is a sharp decrease in density that terminates the layer on the bottom side at a variable altitude near the mesopause. This decrease appears to become sharp only some time after twilight, suggesting that the sodium consumption mechanism undergoes a change as the nighttime chemistry is established. The second feature is a fourfold increase in sodium-layer content during a 4-hour period surrounding the transit of the radiant of the Geminids meteor shower on the night of December 13–14, 1971, when the shower was at its peak. (auth)

8185 DAYGLOW [O I] λλ6300 AND 5577-A LINES IN THE EARLY MORNING IONOSPHERE. Schaeffer, R. C. (Johns Hopkins Univ., Baltimore); Feldman, P. D.; Zipf, E. C. J. Geophys. Res.; 77: No. 34, 6828-38(1 Dec 1972).

Data on a developing morning ionosphere have been obtained by rocket measurement of the atomic oxygen red- and green-line airglow emissions and of the composition of the neutral and ionized constituents of the upper atmosphere. The solar zenith angle was 86°. The use of tilting-filter photometers for the optical measurements resulted in reliable and accurate height profiles of the airglow intensity from below 100 to 245 km. The roles of the excitation of both $O(^1D)$ and $O(^1S)$ atoms by the dissociative recombination of O_2^+ and electron impact were studied by using the λλ6300 and 5577-A data in conjunction with the ion composition measurements. The component of photodissociative excitation of $O(^1D)$ by solar radiation in the Schumann–Runge continuum of O_2 absorption was assessed as being approximately twice that determined for a previous rocket experiment. The ion chemistry analysis provided good agreement between the calculated height profile of $O(^1S)$ excitation and the λ5577-A data above 170 km, but, below this height, significant production of $O(^1S)$ through the photodissociation of O_2 by solar radiation at wavelengths shorter than 1334 A was apparent. 25 references. (auth)

8186 COMPARISON OF THEORY WITH EXPERIMENT FOR ELECTRON DENSITY DISTRIBUTION IN THE NEAR WAKE OF AN IONOSPHERIC SATELLITE. Samir, U.; Jew, H. (Univ. of Michigan, Ann Arbor). J. Geophys. Res.; 77: No. 34, 6819-27(1 Dec 1972).

The angular distribution of thermal electrons in the very near wake of an ionospheric satellite computed according to the Liu and Jew theory is compared with experimental values. The space plasma parameters in the computation are based on in situ measurements performed by a Langmuir plate mounted flush on Explorer 31. The quantitative degree of agreement between results from this theory and results from an experiment based on data from eight passes that covered the entire range between perigee and apogee is demonstrated. It is found that for the maximum rarefaction zone most computed values of electron densities are lower than experiment values except at perigee altitudes. The theoretical and experimental limitations of such a comparison are specified, and its implications are discussed. (24 references). (auth)

8187 FURTHER IONOSONDE OBSERVATIONS OF IONOSPHERIC MODIFICATION BY A HIGH-POWERED HF TRANSMITTER. Utlaut, W. F.; Violette, E. J. (Inst. for Telecommunication Sciences, Boulder, CO). J. Geophys. Res.; 77: No. 34, 6804-18(1 Dec 1972).

Ionospheric modification by high-powered hf transmissions has produced many different radio and optical effects, some of which have been reported. Additional effects observed with ionosondes are presented here in more detail so that researchers interested in ionospheric phenomena can examine some of the major and subtle changes and then, perhaps, contribute to new understanding about ionospheric processes. The data shown were obtained with O-mode excitation and provide examples of (a) major deformation of nighttime ionospheric structure, (b) prompt, strong, wideband attenuation of diagnostic O waves on all frequencies exceeding the modifier frequency, and (c) daytime creation of artificial spread F, extending over a range of about 200-km virtual height, and showing different responses in the F1 and F2 regions. (auth)

8188 STABLE ELECTRON DENSITY FLUCTUATIONS IN A PLASMA IN THE PRESENCE OF A HIGH-FREQUENCY ELECTRIC FIELD. Hagfors, T.; Gieraltowski, G. F. (Cornell Univ., Arecibo, Puerto Rico). J. Geophys. Res.; 77: No. 34, 6791-6803 (1 Dec 1972).

The recent series of ionospheric heating experiments conducted by NOAA in Boulder and by Rice University at the Arecibo Observatory have shown that a powerful high-frequency transmitter can excite parametric plasma instabilities in the ionosphere. A theory is developed to describe the changes in the fluctuation spectrum that take place for excitation levels below those required for the instabilities to develop. These stable changes, which can be predicted in detail from theory, might prove valuable as a diagnostic tool if they can be studied by incoherent scatter techniques. It is shown that the raised shoulders in the normal incoherent scatter spectrum can be strongly enhanced when the hf pump frequency is slightly above the plasma frequency. For sufficiently high pump power, these shoulders are transformed into lines upshifted and downshifted from the center frequency by an amount corresponding to the ion acoustic velocity, and they approach infinity at a critical hf field strength. When the pump frequency lies at the frequency for longitudinal electron plasma oscillations, a single maximum occurs in the spectrum centered on zero frequency offset. This maximum also approaches infinity for a critical pump field slightly higher than in the former case. A similar situation exists in the vicinity of a frequency offset either upward or downward from zero frequency by the pump frequency when the

latter is near the plasma frequency. The ion acoustic features have counterparts in two spikes centered on the pump frequency but with the stronger spectral feature always on the zero frequency side of the pump. The zero frequency line in the ion acoustic spectrum has a counterpart at the pump frequency. The variation of the spectral shape with various parameters is illustrated by sets of curves in which one parameter is varied at a time. The height regions over which the stable distortions in the spectrum will occur in the ionosphere will normally be so thin that observation of the phenomenon by incoherent scatter techniques may be at best difficult. For a pump frequency near the maximum plasma frequency of the F layer, however, observation of the spectral distortion might be possible. (auth)

8189 THEORETICAL MODEL FOR THE LATITUDE DEPENDENCE OF THE THERMOSPHERIC ANNUAL AND SEMI-ANNUAL VARIATIONS. Mayr, H. G. (Goddard Space Flight Center, Greenbelt, MD); Volland, H. J. Geophys. Res.; 77: No. 34, 6774-90(1 Dec 1972).

A three-dimensional model for the annual and semiannual variations of the thermosphere is presented in which the energy and diffusive mass transport associated with global circulation are considered in a self-consistent form. It is shown that these processes play a major role in thermosphere dynamics and thus account for a number of temperature and composition phenomena such as (1) the helium and oxygen bulges in the winter hemispheres at lower altitudes, (2) the relatively large temperature variations (~26%) in the annual component, which exceed by a factor of 3 those temperatures inferred from the satellite drag data and would be much too large for a thermosphere in diffusive equilibrium, (3) the 7% variation of the exospheric temperature at the poles in the latitude dependent semiannual component associated there with a significant depletion of oxygen and helium during the equinox, and (4) the nearly height independent and relatively small amplitudes in the total mass density of the latitude dependent components that are responsible for the fact that the latitude variations of the semiannual effect have so far eluded observations from satellite drag data and that the globally uniform component of the semiannual effect appears to be relatively strong in comparison with the annual variations. (30 references). (auth)

8190 FEASIBILITY OF GROUND-BASED GENERATION OF ARTIFICIAL MICROPULSATIONS. Greifinger, C. (R and D Associates, Santa Monica, CA). J. Geophys. Res.; 77: No. 34, 6761-73(1 Dec 1972).

The magnetic field generated by a ground-based horizontal frame antenna operating in the Pc-1 frequency range is calculated for different ionospheric conditions. The generated signal can propagate laterally in the ionospheric waveguide and, as a result of mode conversion in the lower ionosphere, upward into the magnetosphere along the field lines above the source. For (nighttime) waveguide propagation, generation of fields of the order of 10 mγ at distances of thousands of kilometers requires the magnetic moment of an antenna of the order of 100 km in radius carrying a current of the order of 1 ka. A magnetic moment of the same order will produce upward-going fields of the order of tens of milligammas at the top of the ionosphere, for either daytime or nighttime conditions. Generation of micropulsations by a ground-based rotating superconducting magnet is briefly considered and is found to be well outside the range of current feasibility. (auth)

8191 AURORAL HELIUM PRECIPITATION. Axford, W. I. (Univ. of California, San Diego, La Jolla); Buehler, F.; Chivers, H. J. A.; Eberhardt, P.; Geiss, J. J. Geophys. Res.; 77: No. 34, 6724-30(1 Dec 1972).

The metal-foil sampling technique was used to measure helium, neon, and argon fluxes in the solar wind, and was adapted to the problem of measuring the fluxes of these gases in the auroral primary radiation. Aluminum and platinum foils were flown into two bright auroras and recovered. The foils were analyzed for helium and neon isotopes with a mass spectrometer; so far only ^{4}He was detected, but with a more sensitive mass spectrometer it should be possible to detect ^{3}He. In the first flight the precipitating flux of ^{4}He with particle energies above about 1 keV was approximately 1×10^6 cm^{-2} sec^{-1}, and the backscattered flux was smaller by about a factor of 10. In the second flight the aurora was less bright, and the ^{4}He fluxes were lower by a factor of about 2. A rough analysis suggests that the mean energy of the incident particles was >3 keV. These fluxes are consistent with measurements of the ion fluxes observed at high altitudes in the auroral zone and in the magnetosphere, if it is assumed that the helium contributes a few per cent of the total flux. (28 references). (auth)

8192 OBSERVATIONS SUGGESTING WEAK PITCH-ANGLE DIFFUSION OF PROTONS. Berg, L. E.; Soeraas, F. (Univ. of Bergen). J. Geophys. Res.; 77: No. 34, 6708-15(1 Dec 1972).

A pronounced longitude variation in the intensity of locally mirroring protons above 100 keV in the L range 3.5 to 5 at low altitudes is observed. The observations can be accounted for by a steady-state pitch-angle diffusion process. The pitch-angle diffusion coefficient for protons mirroring near the loss cone at L = 4 is found to be about 10^{-6} sec^{-1}. (auth)

8193 PRECIPITATION OF LOW-ENERGY ELECTRONS AT HIGH LATITUDES: EFFECTS OF INTERPLANETARY MAGNETIC FIELD AND DIPOLE TILT ANGLE. Burch, J. L. (Goddard Space Flight Center, Greenbelt, MD). J. Geophys. Res.; 77: No. 34, 6696-6707(1 Dec 1972).

Data from the auroral particles experiment on Ogo 4 were used to study effects of interplanetary magnetic-field latitude and dipole tilt angle on high-latitude precipitation of low-energy electrons. It was found that: (1) The low-latitude boundary of polar-cusp electron precipitation at 0900 to 1500 MLT moves equatorward by several degrees during substorms and, in the absence of significant substorm activity, after a period of southward interplanetary magnetic field. This behavior is interpreted to result from erosion of dayside magnetic flux into the tail and to be a part of the substorm growth phase. Comparisons of southward solar-wind magnetic flux and the eroded magnetic flux indicate a merging efficiency of 5 to 30%. Expected cross-tail electric potentials lie in the range 36 to 84 kV, in reasonable agreement with observation. (2) With times containing substorm activity or a southward interplanetary magnetic field eliminated, the low-latitude boundary of plar-cusp electron precipitation is found to move by approximately 4° over the total yearly range of tilt angles. At maximum winter and summer conditions, the invariant latitude of the boundary is shown to shift by approximately –3° and +1°, respectively, from its equinox location. This same asymmetry is found in calculations of the invariant latitude of the first open field line in the Mead–Fairfield model magnetosphere. The observed polar-cusp lower boundaries lie approximately 3° below the calculated first open field lines and coincide with the average >35-keV electron boundaries of Feldstein and Starkov. 36 references. (auth)

8194 SEASONAL AND LATITUDE VARIATIONS IN THE PROPERTIES OF THE THERMOSPHERE (STEADY-STATE MODEL). Gridchin, G. V.; Ivanovskii, A. I.; Marchevskii, V. A.; Repnev, A. I. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 2, 213-17(1972).

Translated from Kosm. Issled.; 10: No. 2, 239-44(1972).

A steady-state model of the thermosphere is used to calculate the seasonal and latitude variations in the properties of the thermosphere at the solar minimum. (auth)

8195 DETERMINATION OF THE ELECTRON COLLISION FREQUENCY IN THE E REGION OF THE IONOSPHERE FROM ROCKET AND GROUND-BASED MEASUREMENTS DURING THE FLIGHT OF THE VERTICAL-1 ROCKET. Bischoff, K.; Gringauz, K. I.; Klein, G.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 10: No. 2, 204-12(1972).

Translated from Kosm. Issled.; 10: No. 2, 228-38(1972).

The height profile of the electron collision frequency $\nu_{eff}(h)$ in the ionosphere up to a level of ≈105 km is derived from measurements of the absorption of radio waves during the flight of the Vertical-1 rocket (November 28, 1970), as carried out with ground-based equipment developed by the Academy of Sciences of East Germany. Values of the electron density measured simultaneously with a dispersion radio interferometer (USSR) carried by the rocket have been utilized. In addition to a report of the results, the instrumentation and measurement procedures are described briefly. (auth)

8196 STUDIES OF THE LOWER IONOSPHERE BY MEANS OF VLF PROPAGATION OVER LONG DISTANCES. Rinnert, K. (Max-Planck Institut fuer Aeronomie, Lindau, Ger.). Z. Geophys.; 38: No. 4, 719-47(Oct 1972). (In German).

The diurnal amplitude- and phase-changes of signals of distant vlf transmitters are interpreted with the aid of mode theory. For a constant height profile of collision frequency ν and neglecting the Earth magnetic field, electron-density, profiles above 40 km are given that can explain recordings in the frequency range 10.2 to 24.0 kHz. By means of model calculations, information is obtained about disturbances of the normal height distribution of electron density (PCA events and solar x-ray events). The calculation of mode conversion at the terminator, leading especially at higher frequencies to characteristic mode interference, requires different electron-density profiles at sunset and sunrise. (tr-auth)

Effects of Nuclear Detonations

8197 MEASUREMENT OF THE ^{3}H β-RAY SPECTRUM AND DETERMINATION OF AN UPPER LIMIT FOR THE ELECTRON-

ANTINEUTRINO REST MASS. Roede, B. (Univ., Munich); Daniel, H. Lett. Nuovo Cim.; 5: No. 2, 139-43(9 Sep 1972).

The upper part of the ^3H beta spectrum was measured using four sources and a high-resolution magnetic spectrometer. In order to evaluate the measured spectra, Fermi plots, with assumed values for the neutrino rest mass and the maximum energy, were constructed for the three stronger sources, with the spectrometer resolution and the computed values of the energy loss folded in and compared with the experimental points. (W.D.M.)

Magnetospheric Phenomena

Refer also to abstracts 8173 and 8765.

8198 (AD-742518) HIGH-LATITUDE PHENOMENOLOGY. Final Report. McCormac, B.; Evans, J. E.; Sears, R. D.; Berg, R. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). Jun 1971. Contract DASA01-71-C-0085. 63p. (LMSC/D-179555; DNA-2861-F). NTIS.

The solar wind furnishes the power for a number of energetic high-latitude phenomena. The overall magnetospheric morphology is described. The interaction begins with a description of the solar wind and then leads through the magnetospheric structure. The energetic-particle precipitation is described. The sources of the various electron and proton precipitation areas are identified. Much of the plasma and energetic particle behavior as governed by the Earth's magnetic field is described. The plasma and particle populations in the various regions of the magnetosphere are identified. A number of fluctuating phenomena in the magnetosphere are described. Current systems and heat conduction are discussed. (GRA) (auth)

8199 (AD-742757) THEORY AND COMPUTER SIMULATION OF WHISTLER TURBULENCE AND VELOCITY SPACE DIFFUSION IN MAGNETOSPHERIC PLASMA. Ossakow, S. L.; Ott, E.; Haber, I. (Naval Research Lab., Washington, D. C.). Apr 1972. 43p. (NRL-MR-2432). NTIS.

The nonlinear development of unstable whistler waves and their interaction with electrons in an anisotropic, collisionless, magnetospheric-type plasma is investigated by theory and computer simulation experiments. A two component plasma is considered; a hot electron Maxwellian component with 60 degree loss cone is superimposed on a cold isotropic electron background. The linear and quasilinear theory is developed and quasilinear theory is used to obtain equations for the temporal evolution of the parallel and perpendicular energy for the hot and cold plasma components. The computer code follows the nonrelativistic dynamics of a large number of charges in their self-consistent electromagnetic fields. Three velocity and one spatial dimension are used. The simulation automatically includes energy as well as pitch-angle diffusion. (GRA) (auth)

8200 (AD-742980) INNER-ZONE ENERGETIC ELECTRON REPOPULATION BY RADIAL DIFFUSION. Report for October 1969-November 1971. Vampola, A. L.; Tomassian, A. D.; Farley, T. A. (Aerospace Corp., El Segundo, Calif. California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics). 22 May 1972. Contract F04701-71-C-0172. 45p. (SAMSO-TR-72-111). NTIS.

A quantitative study of the intrusion of natural electrons into the inner radiation zone during and after the geomagnetic storm of September 2, 1966 shows that the transport is consistent with a radial diffusion mechanism in which the first two invariants are conserved. (GRA) (auth)

8201 RECENT SATELLITE MEASUREMENTS OF THE MORPHOLOGY AND DYNAMICS OF THE PLASMASPHERE. Chappell, C. R. (Lockheed Palo Alto Research Lab., Palo Alto, CA). Rev. Geophys. Space Phys.; 10: No. 4, 951-79(Nov 1972).

The very low-energy thermal plasma (~1 eV or several thousand degrees Kelvin) is often overlooked in reviews of magnetospheric plasma populations, usually as a result of energy considerations in which thermal particles are believed unimportant. In reality this cold plasma, which surrounds the Earth in a region known as the plasmasphere, has an important direct influence on the characteristics of the ionospheric F region and on the location of regions of plasma turbulence in the magnetosphere, and it is an excellent indirect measure of the intensity of magnetospheric convection. The characteristic morphology and dynamics of the plasmasphere vary with local time and with geomagnetic conditions. On the nightside the plasmapause position changes predictably with changing magnetic activity. Once established at a specific L-shell value, the steep density gradient on the nightside corotates into the dayside, where filling from the ionosphere takes place. In the duskside bulge region the characteristic density profile inside the plasmapause displays a smooth decrease proportional to $1/R^4$, where R is radial distance. Plasmasphere morphology and dynamics can be understood in terms of a time-varying convection electric-field model of the magnetosphere that includes the bulge region as part of the main circulation pattern of the plasmasphere. (43 references). (auth)

8202 PRECIPITATION OF AURORAL AND RING CURRENT PARTICLES BY ARTIFICIAL PLASMA INJECTION. Cornwall, J. M. (Aerospace Corp., El Segundo, CA). Rev. Geophys. Space Phys.; 10: No. 4, 993-1002(Nov 1972).

Outside the plasmasphere, most of the energy in magnetospherically trapped particles resides in two populations, auroral-energy electrons and the proton ring current, with single-particle energies from 1 to 50 keV. The ring current contains more energy than all other components of the magnetospherically trapped radiation. It may be possible to precipitate a large fraction of this energy into the ionosphere by injection of a light-ion plasma from a synchronous satellite; this would render the ring current protons unstable to a variety of plasma modes. Auroral-energy electrons can be precipitated by ions of any mass, but heavy (e.g., barium) ions will quench what may be the most important proton instability, which takes place in the electromagnetic ion cyclotron mode. This mode is unstable only if the ring current protons have an average velocity greater than the wave phase velocity. The wave speed varies as $N^{-\frac{1}{2}}$, where N is the cold plasma density; under natural conditions, N is too small for the ring current to be unstable outside the plasmapause. Injection of some tens of pounds of lithium ions at synchronous altitude will create an unstable region with a diameter of a few thousand kilometers; as a result of the instability, ring-current protons will precipitate into the ionosphere at a rate up to 1 erg cm^{-2} sec^{-1}. This should produce important effects in the upper E and F layers of the ionosphere. At the same time, precipitating auroral-energy electrons may create auroras and other effects usually associated with geomagnetic storms. (36 references). (auth)

8203 INFERRING THE INTERPLANETARY MAGNETIC FIELD BY OBSERVING THE POLAR GEOMAGNETIC FIELD. Wilcox, J. M. (Stanford Univ., CA). Rev. Geophys. Space Phys.; 10: No. 4, 1003-14(Nov 1972).

L. Svalgaard and S. M. Mansurov have shown that it is possible to infer the polarity of the interplanetary magnetic field quite reliably from observations of the diurnal variation of polar geomagnetic fields. The effect is most prominent in the vertical component of geomagnetic observatories near the geomagnetic poles during several hours near noon. The interplanetary magnetic field observed with spacecraft near the Earth is very similar to the mean solar magnetic field (i.e., the Sun observed as though it were a star); thus the fact that observations of the polar geomagnetic field have existed without interruption since 1926 at the Danish Meteorological Institute station at Godhavn, Greenland, means that in effect the inferred solar magnetic field during five sunspot cycles is available for analysis. The specific nature of the relation between the interplanetary field and the polar geomagnetic field should aid toward physical understanding of the interaction between the two fields. It has already been shown that it is the direction of the azimuthal (i.e., not the radial or north-south) component of the interplanetary field that is significant in causing this effect. (24 references). (auth)

8204 SHADOWING OF ELECTRON AZIMUTHAL-DRIFT MOTIONS NEAR THE NOON MAGNETOPAUSE. West, H. I.; Buck, R. M.; Walton, J. R. (Univ. of California, Livermore). Nature (London) Phys. Sci.; 240: No. 97, 6-7(6 Nov 1972).

The work of Roederer (J. Geophys. Res., 72: 981(1967)) on the azimuthal drift of geomagnetically trapped electrons in the distorted outer regions of the Earth's magnetosphere is discussed, with special reference to the effects of noon magnetopause shadowing of the drift paths. Data are also given for experiments on the NASA OGO-5 spacecraft, using a magnetic electron spectrometer. (UK)

8205 VELA 4 LYMAN-α OBSERVATIONS: EVIDENCE FOR AN ASPHERICAL HYDROGEN GEOCORONA AT 18 R_E. Fehlau, P. E.; Chambers, W. H.; Kunz, W. E.; Fuller, J. C. (Los Alamos Scientific Lab., NM). J. Geophys. Res.; 77: No. 34, 6665-70(1 Dec 1972).

Observations of scattered solar hydrogen Lyman-α radiation made with detectors carried by satellites Vela 4A and 4B show a repetitive and marked asymmetry in the Lyman-α flux. The detectors look radially outward from the Earth at an altitude of 110,000 km. The axis of the 34° angle of view lies in the plane of the circular satellite orbit, which is inclined 32° to the equator. The distinctive characteristic of the data for the period May 13, 1967, to July 31, 1967, is a broad maximum in the flux. In a preliminary interpretation, the detectors were above the hydrogen

geocorona and the scattering hydrogen, which gives rise to the broad maximum, must be in interplanetary space. Detailed analysis of the data for many orbits indicates that the most precisely located feature of the data, the leading edge of the broad maximum, moves in right ascension at about the same rate and in the same direction as the motion of the Earth projected on the celestial sphere. Thus, a significant part of the scattering hydrogen moves with the Earth, and the observations are interpreted as evidence for an aspherical geocorona with an increased density of hydrogen beyond 18 R_E on the night side. The view direction is above the ecliptic plane when the maximum is observed. After an estimated interplanetary component is subtracted from the observed maximum flux, the scattered Lyman-α intensity from telluric hydrogen beyond 18 R_E is about 150 rayleighs. The column density of hydrogen above 18 R_E when the maximum is observed is 6 to 7 $\times 10^{10}$ atom cm^{-2} in the plane of the satellite orbit. (auth)

8206 CHARACTERISTICS OF THE LUNAR PHOTOELECTRON LAYER IN THE GEOMAGNETIC TAIL. Reasoner, D. L.; Burke, W. J. (Rice Univ., Houston, TX). J. Geophys. Res.; 77: No. 34, 6671-87(1 Dec 1972).

The charged-particle lunar environment experiment (CPLEE), a part of the Apollo-14 lunar surface package, is an ion–electron spectrometer capable of measuring ions and electrons with energies between 40 eV and 50 keV. The instrument, with apertures 26 cm above the surface, has detected a photoelectron gas layer above the sunlit lunar surface. No detectable flux above 200 eV has been observed. Experimental data for periods while the moon was in the Earth's magnetotail for electrons with energies 40 eV $\leq E \leq$ 200 eV follow a power-law spectrum $j(E) = j_0(E/E_0)^{-\mu}$ with $3.5 \leq \mu \leq 4$. In the absence of photoelectrons with E > 200, the surface potential is assumed to be at least 200 volts. The modulation of this potential in the presence of intense plasma-sheet fluxes has been observed. Also, a detailed history of the February 10, 1971, total lunar eclipse, to determine the source distribution of high-energy solar photons, is presented. A classical penumbral–umbral behavior indicates that at the time of the eclipse the emission of higher-energy photons was uniform over the solar disc. Numerical solutions for the variation of electron density and potential as functions of height above the lunar surface were obtained. The solar photon spectrum $I(h\nu)$, obtained from various experimental sources, and the photoelectron yield function of the surface materials, $Y(h\nu)$, are two parameters of the solution. Energy spectra at the height of the measurements for various values of $Y(h\nu)$ were computed until a fit to experimental data was obtained. Using a functional form $Y(h\nu) = [Y_0(h\nu - W)/(W/2)]$ for 6 eV $\lesssim h\nu \lesssim$ 9 eV and $Y(h\nu) = Y_0$ for $h\nu >$ 9 eV, where the lunar-surface work function W was set at 6 eV, a value was calcuated of $Y_0 = 0.1$ electrons photon. The solution also showed that the photoelectron density falls by 5 orders of magnitude within 10 meters of the surface, but the layer actually terminates several hundred meters above this height. A hydrostatic model of the photoelectron layer has also been developed. It is shown that the numerically calculated pressure, density, and potential can be approximated by solving the hydrostatic equations with an equation of state $P/n^{\gamma} =$ constant out to 200 cm from the surface. Beyond this height, the equation of state shifts toward the isothermal case, P/n = constant. (auth)

8207 OUTFLOW OF PLASMA FROM THE MAGNETOTAIL INTO THE MAGNETOSHEATH. Hones, E. W. Jr.; Akasofu, S. I.; Bame, S. J.; Singer, S. (Los Alamos Scientific Lab., NM). J. Geophys. Res.; 77: No. 34, 6688-95(1 Dec 1972).

It is inferred from measurements of proton fluxes with electrostatic analyzers on the Vela satellites that plasma leakage from the magnetosphere into the magnetosheath is rather commonplace and may be strongly enhanced during magnetospheric substorms. It is suggested that this leakage accounts for the loss of at least some of the plasma that leaves the thinning plasma sheet early in a substorm. When a Vela satellite is in the magnetosheath, its electrostatic analyzer detects a flux of protons of energy of ~1 keV that is strongly modulated, owing to the rotation of the satellite in the rapidly flowing magnetosheath plasma. When they are in this environment, the analyzers sometimes also detect fluxes of protons of energy of ~10 to 30 keV with intensities characteristic of those in the magnetotail plasma sheet, and in many cases these fluxes appear during substorms. Simultaneous measurements by two Vela satellites, one in the magnetosheath and one in the solar wind, show conclusively that these protons do not originate in the solar wind. Spatial variations of their intensity across the magnetosheath suggest further that they come not from the bow shock but from the magnetosphere. (auth)

8208 LIGHT-ION TROUGH, THE MAIN TROUGH, AND THE PLASMAPAUSE. Taylor, H. A. Jr. (Goddard Space Flight Center, Greenbelt, MD); Walsh, W. J. J. Geophys. Res.; 77: No. 34, 6716-23(1 Dec 1972).

Extensive observations of midlatitude depletions in electron and total ion density by both direct and indirect techniques have prompted numerous studies of the possible association between these troughs, observed both in the F region and in the topside ionosphere, and the plasmapause. Within this work, one basic problem arises in that, although the plasmapause has been detected as a global phenomenon by both vlf and ion composition measurements, the electron and ion density troughs have been identified primarily as nightside features. This problem, as well as the difficulty in explaining various inconsistencies in relating the position of the plasmapause and the ionization trough, is explained by a close examination of the ion composition, generally unavailable in previous trough studies. In particular, ion composition results from the polar-orbiting Ogo satellites identify the persistence of a pronounced light-ion trough (LIT) in H^+ and He^+, often identified by order-of-magnitude decreases in the light-ion concentrations that occurs within a few degrees of latitude and reaches residual concentration levels of 10^2 to 10^3 ions/cm^3 near 60° dipole latitude. The LIT, observed both within the thermosphere and at high latitudes in the magnetosphere has been correlated directly with the vlf whistler identification of the plasmapause. On the nightside near 1000 km a complex relationship is observed between the dominant ions O^+ and H^+. The rapidly changing mean ion mass observed at the plasmapause typically produces a resultant total ion density distribution of complexity sufficient to confuse correlative studies with the plasmapause, even though the LIT is very sharply defined within the ion composition. On the dayside, where O^+ is typically the predominant ion near 1000 km, LIT structure is often hidden beneath the O^+ layer, which may exhibit little or no depletion even though H^+ and He^+ show trough structure at the plasmapause. This analysis of the midlatitude topside ion composition indicates the need for caution both in studies of the plasmapause per se and in phenomenological studies such as the relationship between the subauroral red arc and the plasmapause, which are most likely dependent on the detailed information available within the ion composition. (auth)

8209 MORPHOLOGY AND INTERPRETATION OF MAGNETOSPHERIC PLASMA WAVES AT CONJUGATE POINTS DURING DECEMBER SOLSTICE. Lanzerotti, L. J.; Hasegawa, A.; Tartaglia, N. A. (Bell Labs., Murray Hill, NJ). J. Geophys. Res.; 77: No. 34, 6731-45(1 Dec 1972).

The morphological characteristics of magnetospheric plasma waves (period $\tau \sim$ 18 to 150 sec) detected at conjugate points near L = 4 during the winter solstice are studied. No magnetospheric waves that satisfy an imposed strict selection criterion are observed after ~1700 LT. Approximately half the 94 accepted events are left-hand polarized. No significant change in the polarization characteristics of the waves is observed as a function of local time. Approximately 16% of the events have opposite polarizations in the two hemispheres. The morphological polarization characteristics are discussed in the context of expected body- and surface-wave polarizations. The observed polarizations do not readily support a surface wave arising from the Kelvin–Helmholtz instability on the magnetopause as a source for all the events. All but two of the left-hand and right-hand wave events were symmetrical about the meridian plane, implying a predominant in-phase oscillation of the H component of the wave at each station and an out-of-phase oscillation of the D component. (45 references). (auth)

8210 RELATION OF Pc1 MICROPULSATIONS TO THE RING CURRENT AND GEOMAGNETIC STORMS. Heacock, R. R. (Univ. of Alaska, Fairbanks); Kivinen, Matti. J. Geophys. Res.; 77: No. 34, 6746-60(1 Dec 1972).

The Pc 1 micropulsations were recorded at College, Alaska, Thule, Greenland, and at Sodankyla and Nurmijarvi, Finland, from November 1967 through January 1970. Cross-correlation analysis disclosed a significant tendency for periodically structured Pc 1 to occur during ring-current recoveries. Semistructured and unstructured Pc-1 and -2 activity tends to occur in the initial phase and in the early part of the growing phase of magnetic storms. Source lines for structured Pc-1 events are principally on the dayside. These results are related to theoretical results of Kennel and Petscheck, Cornwall and associates, and Brice and Lucas; i.e., the plasmasphere fills during the storm recovery phase, preferentially on the dayside, and the intersection of the ring current with the increasing cold-plasma density of the plasmasphere results in the cyclotron instability when the stable trapping limit is reached. (52 references). (auth)

8211 ANISOTROPY OF LOW-ENERGY SOLAR PROTONS AT THE BOUNDARY OF THE MAGNETOTAIL. Cooper, W. A. (Open Univ., Bletchley, Eng.); Haskell, G. P. J. Geophys. Res.; 77: No. 34, 6849-53(1 Dec 1972).

Changes in the anisotropy of low-energy solar protons on crossing the boundary of the magnetotail have been studied. Protons of

energy 1 to 13 MeV were observed by the Heos-1 satellite during a multiple crossing of the boundary on June 8, 1969. The position of the boundary was determined by simultaneous measurements of the magnetic field and the solar-wind plasma. The results show that the anisotropy penetrated about 1 gyroradius into the tail and that the direction of the anisotropy was sometimes aligned with the magnetic field in the tail and sometimes at right angles to it. These results, together with those of Montgomery and Singer (1969), suggest that the nature of the boundary is variable. The present observations suggest that the boundary sometimes appears to ~1-MeV protons as a tangential discontinuity but that sometimes there is direct connection between a magnetic flux tube on the surface of the tail and a flux tube in the magnetosheath. (auth)

8212 NONLINEAR WAVES IN GEOMAGNETIC WAKE. Ershkovich, A. I.; Nusinov, A. A.; Chernikov, A. A. (Inst. for Space Research, Moscow). J. Geophys. Res.; 77: No. 34, 6907-10(1 Dec 1972).

Observations by Pioneer 8 in the geomagnetic wake region at the geocentric distance of 500 R_E have shown fluctuations with the characteristic time of some tens of minutes. Data obtained by Pioneer 7 at 1000 R_E also represent such fluctuations. Preliminary analysis of Mars-3 data obtained at 3000 R_E shows fluctuations with the period of the order of an hour. The nature of these fluctuations seems to be connected with the Kelvin–Helmholtz instability arising in the magnetotail at large distances from the Earth; because of the instability, the tail loses the regular structure and is transformed into a geomagnetic wake. The tail is considered as a plasma cylinder with a free boundary immersed in the solar wind, and is shown to be stable for small disturbances with typical plasma parameters. The nonlinear effects arising when the oscillation amplitudes are finite are estimated. (J.C.W.)

8213 TWO SUBSTORM STUDIES OF RELATIONS BETWEEN WESTWARD ELECTRIC FIELDS IN THE OUTER PLASMASPHERE, AURORAL ACTIVITY, AND GEOMAGNETIC PERTURBATIONS. Carpenter, D. L. (Stanford Univ., CA); Akasofu, S. I. J. Geophys. Res.; 77: No. 34, 6854-63(1 Dec 1972).

In two case studies of magnetospheric substorms, temporal variations of the westward component of the magnetospheric convection electric field in the outer plasmasphere were compared with auroral activity near L = 7 and with variations in the geomagnetic field at middle and high latitudes. The substorms occurred on July 29, 1965, near 0530 UT and on August 20, 1965, near 0730 UT. The results on the westward electric field E_w were obtained by the whistler method with data from Eights, Antarctica (L ~ 4). All-sky camera records were obtained from Byrd, Antarctica (L ~ 7), located within about 1 hour of Eights in magnetic local time. It was found that E_w within the outer plasmasphere increased rapidly to substorm levels of ~0.5 Mv/m about the time of auroral expansion at nearby longitudes. This behavior differs from results obtained from electrostatic probes on balloons, which show E_w reaching enhanced levels before the expansion. A close temporal relation was found between the rapid substorm-associated increase in E_w and a well-known type of nightside geomagnetic perturbation. Particularly well defined was the correlation of E_w rise with a large deviation of the D component at middle latitudes. (auth)

8214 aa INDICES: A 100-YEAR SERIES CHARACTERIZING THE MAGNETIC ACTIVITY. Mayaud, P. N. (Univ., Paris). J. Geophys. Res.; 77: No. 34, 6870-4(1 Dec 1972).

After the 100-year series of the aa indices is described, two results are set forth. The general trend of the activity variation permits the forecast of a very-low level of intensity (3 to 4 in Ap units for the yearly values) during the next solar minimums (this finding would be of interest in magnetospheric studies), and the annual variation of the activity is definitely proved. (auth)

8215 COSMIC-RAY SCINTILLATIONS. I. INSIDE THE MAGNETOSPHERE. Owens, A. J.; Jokipii, J. R. (California Inst. of Tech., Pasadena). J. Geophys. Res.; 77: No. 34, 6639-55(1 Dec 1972).

Evidence is presented for the existence of statistically significant broad-band fluctuations, far above noise level, in the cosmic-ray flux observed inside the magnetosphere. The observed intensities at the polar cap at both low and high energies were analyzed, and power spectra of the cosmic-ray scintillations are presented and discussed. The low-energy data obtained during quiet times strongly suggest that, if δj is the fluctuation in intensity about the mean j_0, the spectrum of $\delta j/j_0$ is nearly constant for widely varying values of j_0. The spectra are roughly inverse power laws in frequency, with slopes of -1.5 to -2. The magnitudes of the spectra of $\delta j/j_0$ are much smaller at high energies than at low. A plausible, illustrative model for the propagation of cosmic rays through the turbulent magnetic field in the magnetosheath is presented, and a relationship between the observed cosmic-ray power spectrum and the magnetosheath magnetic-field power spectrum is obtained. It is shown that magnetic fluctuations in the magnetosheath can reasonably account for the observed cosmic-ray scintillations in the low-energy region (1 to 40 MeV), although other interpretations cannot be ruled out. Other possible mechanisms are briefly discussed. The scintillations of cosmic rays of neutron monitor energies are not explained by this model and may be interplanetary in origin. (auth)

8216 NOTE ON THE GEOMAGNETIC SPECTRUM. Currie, R. G. (Council for Scientific and Industrial Research, Hermanus, South Africa). J. Geophys. Res.; 77: No. 34, 6893-5(1 Dec 1972).

A detection of a 54-day line in spectra of the Ap index with an amplitude of 1.27 γ led to a suggestion that some active regions on the Sun may modulate with a period twice the average solar-rotation period. Some unpublished evidence for a similar line in H component magnetic power spectra is given. Twenty-eight H component power spectra from a worldwide distribution of observatories were examined and peaks in the range 40 to 80 days listed. Peaks near 54 days (0.745 cycles/40 days) were divided into three classes with the results of (1) 11 spectra showed a peak above the noise level and above all adjacent peaks; (2) 8 spectra had a peak above the noise level, but there were other peaks in the range with as high a power level; (3) 9 spectra showed no peak at 54 days. Two of the class 3 spectra were from observations taken in the nineteenth century and three others from the early twentieth century. (J.C.W.)

8217 USE OF AN ELECTRON BEAM FOR LOW-TEMPERATURE PLASMA MEASUREMENT IN THE MAGNETOSPHERE AND INTERPLANETARY SPACE. Kawashima, Nobuki (Tokyo Univ.). J. Geophys. Res.; 77: No. 34, 6896-9(1 Dec 1972).

A new method of controlling the spacecraft potential by using a beam of charged particles ejected from the spacecraft and measuring the very low-temperature particle distribution in the magnetosphere and interplanetary space is given. Though the particle spectroscopic measurement in space is an accurate and useful tool, it is well to develop a macroscopic measurement technique to confirm the results and enlarge the range of measurements. Another possibility for its use is as a diagnostic tool for low-density plasma. When the modulation frequency coincides with a characteristic frequency of the plasma, such as the upper hybrid frequency, electron plasma frequency, lower hybrid frequency, electron cyclotron frequency, or ion plasma frequency, resonance phenomena are expected to occur. When a spacecraft is drifting in a plasma with a velocity higher than the ion thermal velocity, a radiation similar to Cherenkov radiation is expected to be emitted when the spacecraft is charged up to a sufficient voltage by an electron beam emission. These resonance phenomena would also be useful for obtaining information on the characteristics of low-temperature plasma in the magnetosphere and interplanetary space. (J.C.W.)

8218 12.5-MINUTE PERIODICITY IN SOLAR PROTON FLUXES AT BALLOON ALTITUDE AND IN MAGNETIC MICROPULSATIONS. Greenhill, J. G. (Univ. of Tasmania, Hobart, Australia); Fenton, K. B.; Fenton, A. G.; White, K. S. J. Geophys. Res.; 77: No. 34, 6656-64(1 Dec 1972).

Quasi-periodic 12.5-min fluctuations occurred in the counting rates of Geiger counters and a neutron counter during level flight of a balloon over Wilkes, Antarctica, on September 3, 1966. Correlated fluctuations were observed in the Wilkes magnetometer record. A large solar cosmic-ray event was in progress at the time of the flight. The periodic modulation process is shown to have an energy dependence with a peak at about 50 MeV for solar protons. No periodicity was detected in the Geiger counter telescope rate, which had a proton threshold energy of >110 MeV. It is suggested that the modulation is a result of scattering by hydromagnetic waves in the distant part of the tail. The protons with E > 110 MeV did not pass through the modulating region and probably gained access to the magnetosphere on the dayside. (auth)

8219 ENERGETIC PROTONS AT LOW EQUATORIAL ALTITUDES. Moritz, J. (Christian-Albrechts Univ., Kiel). Z. Geophys.; 38: No. 4, 701-17(Oct 1972).

Protons in the energy range 0.25 to 1.65 MeV have been measured with a solid state detector telescope onboard the German Research Satellite Azur at equatorial latitudes below the radiation belt. The protons with intensities up to 200 p/cm^2 sec ster exhibit a soft spectrum. Their existence is explained by charge-exchange processes in the exosphere and upper atmosphere by which protons that are lost from the outer radiation belt are regenerated at low altitudes. The coupling of the low-altitude population to the outer radiation-belt population is clearly shown in the flux enhancements that both populations suffer from a magnetic-storm event. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Beams and Their Reactions

Refer also to abstracts 8236 and 8923.

8220 (LYCEN-7250) SOME RESULTS ABOUT ION SOURCES IN INHOMOGENEOUS MAGNETIC FIELDS. Tauth, T.; Hadinger, G.; Hadinger-Espi, G.; Bajard, M. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 12p. Dep. NTIS (U. S. Sales Only).

Mathematical models are developed to estimate the yield of multicharged ion sources. A system of differential equations is used to describe the microscopic behavior of the various ions. If certain relations of MHD theory are taken into consideration, together with general laws, it is possible to deduce the ion and electron concentration distributions together with other fundamental parameters such as cross sections, pressures, etc. The ion formation density corresponding to each charge state is determined for various magnetic field configurations, using the results obtained and a Monte Carlo method. (France)

8221 (LYCEN-7253) LASER ION SOURCE: SOME POSSIBILITIES FOR IMPROVEMENT. Bajard, M.; Chabert, A.; Tauth, T. (Lyon Univ. (France). Institut de Physique Nucleaire); Perez, A.; Tonon, G. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Jul 1972. 11p. Dep. NTIS (U. S. Sales Only).

The characteristics of laser-produced plasmas are studied. Suggestions are made of how a beam could be formed from this sort of plasma. Phenomena such as time decoupling between ionic and electronic components, charge exchange processes and energy spread are analyzed. A system which could be used to produce pulses of highly charged ions having a duration of tens of microseconds and suitable for injection into heavy ion accelerators is described. (France)

8222 RECORD OF THE 10th SYMPOSIUM ON ELECTRON, ION, AND LASER BEAM TECHNOLOGY, GAITHERSBURG, MARYLAND, 21-23 MAY 1969. Marton, L. (ed.). IEEE Catalog No. 69 C 22-ED. San Francisco; San Francisco Press, Inc. (1969). 550p. (CONF-690571).

Separate abstracts were prepared for 10 of the 55 papers presented. The remaining 45 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 7876, 7877, 7957, 7969, 7970, 7977, 8223, 8866, 8891, and 8892.

8223 VERSATILE ARC SOURCE FOR ION IMPLANTATION SYSTEMS. Smith, T. C. (Ion Physics Corp., Burlington, Mass.). pp 177-82 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From 10. symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

An arc-discharge ion source that has been operational in the Van de Graaff accelerator of a 2-MV implantation system is described. Ions are obtained from either four gases or two gases and one solid in any arbitrary sequence, without opening the pressure vessel of the accelerator. An ion source test stand is used to determine source operating conditions for many materials prior to running on the accelerator. Operating experience and typical target currents are reviewed. (auth)

8224 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 7, NO. 9. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 50p.

This listing contains 133 references on various aspects of surface and vacuum physics research. (M.O.W.)

8225 COMPRESSION OF HIGH CURRENT RELATIVISTIC ELECTRON BEAMS USING CONVERGING MAGNETIC FIELDS. Davitian, H.; Gardner, W. L. (Cornell Univ., Ithaca, NY). Plasma Phys.; 14: No. 10, 970-4(Oct 1972).

Results are reported of the achievement of high-density beams of electrons using a magnetic-compression technique to focus the beam. (UK)

8226 BACKSCATTERING COEFFICIENT OF ELECTRONS. Zeller, C.; Coulon, J. (Univ., Nancy). Compt. Rend., Ser. B; 275: No. 12, 431-3(18 Sep 1972). (In French).

A very simple theory applicable to incident electrons having energies between 10 and 50 keV was used to determine the backscattering coefficient (ratio of the number of electrons backscattered to the number of incident electrons). A simple analytical result is obtained, which, in spite of the approximations made, agrees very well with the experimental results. (France)

8227 SOME ASPECTS OF THE ELASTIC PLURAL SCATTERING OF ELECTRONS BY ATOMS. Childs, P. A.; Misell, D. L. (Queen Elizabeth Coll., London). J. Phys., D (London); 5: No. 11, 2095-2104(Nov 1972).

An investigation of the effects of plural elastic scattering events on the intensity-angular distributions of electrons scattered in thin films was carried out using single scattering functions based on the free-atom formulation in the first and second Born approximations. Thin films of elements were chosen which were representative of a variation of proton number across the periodic table: carbon (Z = 6), germanium (Z = 32), and gold (Z = 79). The results show that at high incident electron energy (100 keV) the difference in the intensity-angular distributions calculated from single scattering functions in the first and second Born approximations increases with increasing proton number, with correspondingly larger differences for thicker films. The differences for carbon, however, were negligible. A low incident electron energy (10 keV) the above behavior was much more exaggerated, and in the case of carbon the differences were significant. (auth)

8228 BACKSCATTERING OF 0.5 TO 10 keV ELECTRONS FROM SOLID TARGETS. Darlington, E. H.; Cosslett, V. E. (Cambridge Univ., Eng.). J. Phys., D (London); 5: No. 11, 1969-81(Nov 1972).

Measurements were made of electron backscattering in a range of incident beam energy from 0.5 to 10 keV. The variation of backscattering coefficient η with energy and angle of incidence and the energy spectrum of backscattered electrons at incidence and take-off angles of 45° were measured. Results from carbon, aluminium, silicon, copper, and silver were obtained at a pressure of approximately 10^{-8} torr to make the effects of contamination under the electron beam negligible. Various simple theories of the backscattering phenomenon that have been used successfully at higher energies are examined in an attempt to understand the processes producing the observed results. Although the theory of elastic scattering of electrons by atoms at low energies is complicated, it is found that a simple theory based on large-angle elastic collisions may explain the experimentally observed rise in η with fall in beam energy, when an accurate range–energy relationship is used. The variation of η with angle of beam incidence can be explained for low-atomic-number elements by a diffusion theory, but this explanation does not wholly explain the results for copper at low energies. The energy spectra cannot be predicted by any existing simple theory. (auth)

Atomic and Molecular Properties

8229 ANALYSIS OF DOUBLY IONIZED TERBIUM (Tb III). Meinders, E. (Univ., Amsterdam); Van Kleef, Th. A. M.; Wyart, J. F. Physica; 61: No. 3, 443-59(1 Oct 1972).

Analysis of wavelength data of the Tb III spectrum resulted in the detection of 46 odd and 65 even levels. The wavelengths range from 2000 to 6800 Å; more than 2500 lines were recorded, of which 485 are now classified. The odd levels belong to the configurations $4f^9$ and $4f^86p$, the even levels were associated with the configurations $4f^85d$ and $4f^86s$. Semiempirical energy-level calculations were carried out for $4f^8(^7F)$ (5d + 6s), $4f^9$ and $4f^8(^7F)6p$. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstracts 8541, 8660, and 8694.

8230 MUONIUM. Hughes, V. W. (Yale Univ., New Haven). pp 61-89 of Belfer Graduate School of Science Annual Science Conference Proceedings. Vol. 2. /Gelbart, A. (ed.). New York; Marcel Dekker, Inc. (1969).

Work that has been done on muonium is reviewed, and 11 reference papers are listed. Muonium is the simplest system involving the muon and electron and is the best system for studying with precision the interaction of the elementary particles, a positive muon, and an electron. Muonium is a light isotope of hydrogen in which the positive muon replaces the proton, and hence its inter-

actions with other atoms and molecules have been studied. Muonium provides a useful system for studying certain aspects of the weak interaction of the muon and the electron, a possible weak interaction coupling muonium to antimuonium, which is the atom consisting of a negative muon and a positron. (J.C.W.)

8231 THEORETICAL ASPECTS IN THE FIELD OF PIONIC ATOMS. Krell, Max (Sherbrooke Univ., Quebec). pp 1.1-23 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The π–N interaction is studied using a complex optical potential instead of the many-body problem. This interaction is weak in comparison with the nucleon–nucleon interaction; it is assumed that this interaction can be represented at the low energies involved by the scattering integral equation. The scattering operator is used to express this integral in a more explicit form, from which the multiple scattering expansion is obtained. In the case of free nucleons, the pion is assumed not to be strongly absorbed by a single nucleon; in the nucleus a one-nucleon absorption is highly improbable because of the prevailing kinematic conditions; the imaginary part of the potential is thus dependent on a two-nucleon-type density. The measured and calculated values for the broadening of ^{16}O and ^{18}O 2p–1s lines are compared. (7 figures) (France)

8232 π MESIC ATOMS. EXPERIMENTAL. Jenkins, D. (Virginia Polytechnic Inst. and State Univ., Blacksburg). pp 1.25-44 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Neutron distributions in nuclei were studied using pionic atoms. The widths of the 1s and 2p energy levels in pionic atoms are discussed. Although the results concerning neutron distributions are already available some new data about the 1s and 2p level widths are presented. (France)

8233 TRANSFER RATE OF NEGATIVE PIONS FROM GASEOUS HYDROGEN TO ARGON. Picard, J. (European Organization for Nuclear Research, Geneva); Placci, A.; Polacco, E.; (and others). pp 1.59-61 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The mean time interval between the stopping and the nuclear capture of π in gaseous hydrogen (E event) was measured for pressures of 1.4 and 1 atm. abs. The frequency of occurrence of the E events produced in an argon–hydrogen mixture was measured (using the same experimental device) as a function of the partial Ar pressure, for a hydrogen pressure of 1 atm. abs. The delay time corresponding to the π cascade was taken into account; the absolute transfer rate of π from hydrogen to argon was deduced: $\lambda = (4 \pm 1.8) \times 10^9$ sec^{-1}. (France)

8234 PIONIC X-RAY YIELDS AND 2p-LEVEL WIDTHS IN ^{6}Li, ^{9}Be, ^{12}C, AND ^{16}O. Sapp, W. W. Jr.; Eckhause, M.; Miller, G. H.; Welsh, R. E. (Coll. of William and Mary, Williamsburg, Va.). pp 1.63-80 of Proceedings of the International Seminar on $\pm$ Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The intensities of 2p–1s pionic x-ray transitions in ^{6}Li, ^{9}Be, ^{12}C, and ^{16}O were measured using an absolute-efficiency technique. A pion cascade calculation which was constrained to reproduce the observed yields predicted population probabilities for the mesic levels and gave values for the strong-interaction level widths. The 2p-level broadenings are 0.015 ± 0.005 eV for ^{6}Li, 0.016 ± 0.03 eV for ^{9}Be, 2.1 ± 0.6 eV for ^{12}C, and $12 + 4$ eV for ^{16}O. Comparisons are made to results obtained by others and to predictions based upon a semi-phenomenological optical potential. Empirical capture schemes for π^- in ^{6}Li and ^{12}C are also presented. (3 figures) (France)

Collision Phenomena

Refer also to abstract 8041.

8235 (COO–3129-32) LINEAR LEAST-SQUARES FITTING OF MOLECULAR-BEAM DIFFERENTIAL CROSS SECTION DATA USING SPINE FUNCTIONS. Creaser, Roger P. (Brown Univ., Providence, R. I. Metcalf Chemical Lab.); English, R. P.; Kinsey, J. L. (Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry). 1971. 32p. Dep. NTIS.

A method is presented for using spline functions to unfold center-of-mass differential elastic cross sections from scattering data by a linear least-squares technique. The role of various averaging processes in reducing structure in the scattered intensity is illustrated. (auth)

8236 (ORO–2591-69) FORMATION OF EXCITED HYDROGEN ATOMS BY CHARGE TRANSFER AND DISSOCIATION. Progress Report No. 8, December 1, 1971–November 31, 1972. Thomas, E. W.; Ford, J. C.; Sauers, I.; Conrads, R.; Nichols, T. W. (Georgia Inst. of Tech., Atlanta. School of Physics). 30 Nov 1972. Contract AT(40-1)-2591. 36p. Dep. NTIS.

Progress during the period is reported on measurement of (1) total cross sections for formation of 3s, 3p, and 3d excited states of H by H, H^+, H_2^+, and H_3^+ impact on various target gases at 75 to 1000 keV and (2) differential cross sections for formation of H(2s), H^0, and H^+ by H, H_2^+, and H_3^+ impact on gases at 5 to 30 keV. The experimental methods used are described briefly, and important conclusions are summarized. No data are included, but a list of publications in which results will be reported is given. Preliminary studies of excited-state formation and light emission induced by ion impact on metal targets are described briefly. (A.G.W.)

8237 MODIFICATION OF THE CORRELATION APPROXIMATION USED FOR e–H CROSS-SECTION CALCULATION. Felden, M. M.; Felden, M. A.; Braun, J. C. (Laboratoire de Physique des Milieux Ionises, Nancy). Physica; 61: No. 3, 355-60(1 Oct 1972).

The excitation cross sections relative to the transitions 1s $\rightarrow$ 2s, 1s $\rightarrow$ 2p, and ionization for e–H impact were calculated using the correlation approximation which was modified to take into account the neglected term and the peaking approximation. (auth)

8238 OPTICAL MEASUREMENT OF ELECTRON-IMPACT EXCITATION OF HELIUM, NEON, AND KRYPTON IN THE THRESHOLD REGION WITH HIGH ENERGY RESOLUTION. Kisker, E. (Univ., Hamburg). Z. Phys.; 256: No. 2, 121-30 (1972). (In German).

The optical electron-impact excitation functions of p levels of He, Ne, and Kr show a sharp increase at threshold, which is limited by the resolution of the apparatus (appr. 50 meV). Some ten meV above threshold most of them have a first resonance, which is followed by several further ones. In neon there are two strong "W"-profile double resonances, the parent states of which could be the $2p^5$ np(n = 4, 5) states of the Ne atom. (auth)

Atomic Theory

8239 EXACT ANALYSIS OF SPONTANEOUS EMISSION BY A SINGLE TWO LEVEL ATOM IN THE ROTATING WAVE APPROXIMATION. 2. NUMERICAL RESULTS. Swain, S. (Queen's Univ., Belfast). J. Phys., A (London); 5: No. 11, 1601-18(Nov 1972).

The problem considered is that of spontaneous emission by a single two-level atom interacting with N modes of the electromagnetic field in the electric-dipole rotating-wave approximation. The equations derived in a preceding paper (J. Phys., A (London), 5: 1587-1600(1972)) are solved numerically for N = 4, 5, 10, 11, 20, 21, and 201 to find the eigenvalues and various time-dependent properties of the system. The relation between this approach and conventional Wigner–Weisskopf theory is discussed. (auth)

8240 EXACT ANALYSIS OF SPONTANEOUS EMISSION BY A SINGLE TWO LEVEL ATOM IN THE ROTATING WAVE APPROXIMATION. 1. ANALYTIC RESULTS. Swain, S. (Queen's Univ., Belfast). J. Phys., A (London); 5: No. 11, 1587-1600 (Nov 1972).

The problem of a single two-level atom in its excited state, placed in a cavity in which no photons are present initially and interacting with N modes of the electromagnetic field, is solved exactly in the electric-dipole rotating-wave approximation. Expressions for the energy eigenvalues and eigenvectors are derived, and an exact representation for the time-dependent wave function of the system is given. These quantities are evaluated analytically for N = 1, 2, and 3, and the time-dependent properties of the system for these values of N are investigated and discussed. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

Refer also to abstract 8423.

8241 TRANSVERSE HYDROMAGNETIC PLANE WAVES IN THE PRESENCE OF A TEMPERATURE GRADIENT. Takashima, M. (Osaka City Univ.). J. Phys. Soc. Jap.; 33: No. 6, 1712-14 (Dec 1972).

The transverse hydromagnetic plane waves propagating in the horizontal direction in an electrically conducting fluid whose three (viscous, thermal and magnetic) diffusivities are all finite are investigated in the presence of a horizontal magnetic field and a vertical temperature gradient. The propagation characteristics for mercury are shown graphically. The possibility of existence of undamped waves is predicted under astrophysical conditions. (auth)

8242 APPROXIMATE SOLUTIONS TO TWO-DIMENSIONAL POTENTIAL PROBLEMS OF ELECTROHYDRODYNAMICS. Ushakov, V. V. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 4, 140-7(1972). (In Russian).

A system of equations describing plane potential EHD flows at small parameters of interaction, after transition to a new alternating one, was modified to one equation. Its partial solution was found which was the EHD analog to Gamel's equation in the dynamics of viscous liquids. Superposing limitations on the character of the change in electrical parameters along coordinate lines made it possible to distinguish two flow types which were described by the simplified equations: jet and quasi-one-dimensional flow of charged components in a curvilinear electrostatic field and two-dimensional potential flow of medium-carrier. The results of the solution of approximate equations are given for some partial cases. (tr-auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 7960.

8243 TORINO SEARCH FOR QUARKS. I. DELAYED INTERACTIONS OBSERVED UNDERGROUND. Dardo, M. (Univ., Turin); Navarra, G.; Penengo, P.; Sitte, K. pp 1137-43 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Results of the second delayed interactions search for heavy triplet particles representing the results for 6063 showers are reported. In all scintillators the pulse height distributions of the shower runs differed markedly from those found in single muon check runs. Data were separated into 3 pulse height groups for the top scintillators. Of the total showers 2.793 $(46 \pm 1)\%$ were of type "nn" (two normal size pulses) while 933 $(15 \pm 0.5)\%$ were "ss" (two small pulses). The first corresponds to a small pulse probability of 0.32 ± 0.01, the second to 0.39 ± 0.01. There is significant disagreement but both values are drastically higher than the 0.08 recorded for single muons. The overabundance of small pulses suggested the choice of pulse height in the top scintillator as criterion for classification. It is concluded that the existence of a positive delay excess and its distribution strongly refute the argument that all s pulses were of accidental nature. (M.R.M.)

8244 TORINO SEARCH FOR QUARKS. II. PRELIMINARY RESULTS OF A SPARK CHAMBER EXPERIMENT. Picchi, P. (CNEN, Frascati, Italy); Visentin, R.; Briatore, L.; (and others). pp 1144-8 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Spurious events due to low energy secondaries forced the application of statistical corrections, so an effort was made to obtain a better selection by a visualizing technique. A report is made on the first few months operation and analysis is confined to subnormal pulse size in the top detectors, delayed arrival with respect to shower front and production of penetrating secondaries in the absorbers of the array with a mfp distinctly longer than that of conventional strongly interacting particles. (M.R.M.)

8245 SEARCH FOR NEW SPECIES OF PARTICLES IN THE CORES OF EXTENSIVE AIR SHOWERS. Yock, P. C. M.; Chisholm, A. (Univ. of Auckland, N. Z.). pp 1156-9 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

A new theory of subnuclear particles was recently proposed which differs radically from the well known "quark model." The new theory has features in common with Schwinger's recent theory of magnetic monopole "dyons." The theory predicts the existence of delayed particles with masses >10 M_p and electric charges $\neq$ ne or ne/3 in the cores of EAS's. An experiment designed to detect such particles is discussed. The experiment is somewhat similar to that of Dardo et al. (1970). (Australia)

8246 SEARCH FOR e/3 QUARKS IN EXTENSIVE AIR SHOWERS. Ashton, F.; Tsuji, K.; Wolfendale, A. W. (Durham Univ., Eng.). pp 1162-6 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Using a prototype neon flash tube chamber shielded by 15 cm lead a search was made for e/3 charged quarks in regions of extensive air showers where the electron density is >40 m^{-2}. No e/3 quarks were observed in a total running time of 1,177 hours. The upper limit to the flux of e/3 quarks is $2.6.10^{-10} cm^{-2}\ sec^{-1} st^{-1}$ at the 90% confidence level. (Australia)

8247 ENERGY DEPENDENCE OF THE NEUTRAL-TO-CHARGED RATIO AT CHACALTAYA. Hazen, W. E.; Hendel, A. Z.; Weiner, S. R. (Univ. of Michigan, Ann Arbor). pp 1200-4 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Pictures of neutral and charged particles that have undergone a nuclear interaction in one of the plates of a multiplate cloud chamber were examined. The energies of these particles range from 70 to 800 GeV. Within this range the neutral-to-charged ratio for unaccompanied particles is about 0.5 and is independent of energy. There seems to be no dependence of the neutral-to-charged ratio on zenith angle for unaccompanied particles but there is a dependence for accompanied particles. (Australia)

8248 EXTENSION OF F-PLOT. Fukushima, H.; Kobayakawa, K. (Kobe Univ., Japan). pp 1217-23 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

An extension of Duller–Walker's plot (F-plot) is tried by utilizing both the emission angle θ_i and the energy E_i of the secondary particles. If the particle density is expressed as $d^2 N = (No/2)\, f(E^*)dE^*\, d(\cos\theta^*)$ in the rest system of the emission center, $(\gamma\theta)^2$ equals to $\Phi(k,l : \theta)$ which is given as a function of $F(k,l : \theta)$ so defined that $F(k,l : \theta)$ is proportional to the sum of $E_i^{k+1}\, \theta_i^{2l}$ with angles smaller than θ. Four Φ-plots are used to analyze the high energy interactions in the emulsion chambers. It is concluded that in one-third of events the fireball is produced and its mass spectrum is rather broad. (Australia)

Electromagnetic

8249 AS CORES OBSERVED BY SPARK CHAMBERS AND SCINTILLATORS AT MT. NORIKURA. Dake, S. (Kobe Univ., Japan); Asayama, K.; Jitsuno, K.; (and others). pp 948-53 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

An air shower array consisting of 55 spark chambers and 50 scintillation counters are constructed at Mt. Norikura. Particle density response of the spark chamber was compared with the scintillation counters. The consistency of two responses is confirmed up to the particle density $4{,}000/m^2$. Sub showers of AS are easily classified into two groups: jet showers generated in the concrete wall and genuine air showers. The frequency of AS with a genuine sub-shower was several percents, the transverse momentum of which were estimated as several tens GeV/c. Anomalous responses are observed in the scintillation counter compared with spark chamber. (Australia)

8250 RELATION BETWEEN HIGH ENERGY γ-RAYS AND AS CORES. Dake, S. (Kobe Univ., Japan); Hazama, M.; Jitsuno, K.; (and others). pp 954-6 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Since 1967, a series of experiments was performed at Mt. Norikura with a scheme for clarifying the problems whether the ultra large transverse momentum P_t of a fire ball does exist or not, further to estimate the P_t-values, if any anomaly does exist in the ultra high energy region. Two methods using γ-rays in AS cores are described. (Australia)

8251 ENERGY SPECTRUM FROM 5×10^{16} TO 10^{21} eV. Bell, C. J.; Bray, A. D.; Brownlee, R. G.; (and others) (Univ. of Sydney). pp 989-93 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

An outline of a method of calculating the energy spectrum is presented for comparison with the method outlined at Budapest (Brownlee et al. (1969a)). Some experimental results derived from muon size spectra will also be presented, and some actual and projected developments in the experiment will be indicated. (Australia)

8252 SOFT COMPONENT OF LARGE EAS OBSERVED BY SUGAR. Wilson, L. S.; Ulrichs, J.; McCusker, C. B. A.; Loy,

J. G.; Bray, A. D. (Univ. of Sydney). pp 1025-9 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Some preliminary results from a spark chamber charged particle detector associated with the large EAS array SUGAR are presented. (Australia)

8253 ANGULAR DISTRIBUTION OF EXTENSIVE AIR SHOWERS AT LARGE ZENITH ANGLES. Catz, Ph. (Laboratoire de Physique Cosmique, Verrieres le Buisson, France); Gawin, J.; Hochart, J. P.; Maze, R.; Wdowczyk, J. pp 1030-4 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

An analysis of the angular distribution of 50,000 showers recorded independently at two stations enables one to demonstrate a large excess of showers over theoretical expectations for large angles. The muon content of those abnormal showers is also measured and found to be relatively small. Properties of the showers can be explained on the basis of the regenerative mechanism proposed earlier. (Australia)

8254 LONGITUDINAL DISTRIBUTIONS OF ELECTRONS AND MUONS IN THE EAS DISK. Woidneck, C. P.; Boehm, E.; Truemper, J.; de Villiers, E. J. (Univ., Kiel). pp 1038-42 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The longitudinal distributions of electrons and muons in the EAS disk were measured for distances 0 to 100 m from the shower core. The experimental device consists of three fast timing scintillation counters of different area, one of which is shielded by 800 g/cm^2 of concrete. The following results were obtained: The radius of curvature of the electron disk with respect to the muon disk is 600 m. The longitudinal electron distribution becomes flatter with increasing core distance. For the width of the longitudinal muon distribution ($E \geq 2$ GeV) an upper limit of 2 ns (std. dev.) was found. (Australia)

8255 MUON CONTENT OF LARGE EAS. Blake, P. R.; Ferguson, H.; Nash, W. F.; Thomas, D. W. E. (Univ. of Nottingham, Eng.). pp 1044-9 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 3).

A 12.5-m^2 muon detector at Haverah Park was used to investigate the proportion of muons among the secondary particles of EAS. The change of muon content with primary energy was investigated and the results are compared with current theoretical model calculations. (Australia)

8256 VARIATION OF THE MUON CONTENT OF EAS WITH ZENITH ANGLE. Blake, P. R.; Ferguson, H.; Nash, W. F. (Univ. of Nottingham, Eng.). pp 1050-5 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 3).

A 12.5-m^2 muon detector was used to investigate the muon content of an EAS with change of zenith angle. The analysis was carried out on 11,500 showers covering a zenith angle range of 0 → 90°. The results show how the muon lateral density distribution function changes with increasing atmospheric depth. The variation of the muon content of the shower with change of shower size is also investigated as a function of zenith angle. (Australia)

8257 LATERAL DENSITY DISTRIBUTION OF MUONS IN EAS. Blake, P. R.; Ferguson, H.; Nash, W. F. (Univ. of Nottingham, Eng.). pp 1056-61 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The lateral density distribution of muons in EAS was measured using a 12.5-m^2 muon detector installed at Haverah Park. An analysis was carried out on 3,600 showers ($\theta < 25°$), covering the core distance range 100 → 600m. The results are considered in relation to previous work and recent model calculations. (Australia)

8258 MUON BUNDLES IN EAS. Blake, P. R.; Ferguson, H.; Nash, W. F. (Univ. of Nottingham, Eng.). pp 1062-7 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

A 12-m^2 muon detector at Haverah Park was used to investigate the local spatial distribution of muons detected at large distances from the cores of EAS. Although the majority of muons striking the detector appear to be randomly spaced a few records (18 out of 6,000) show evidence for narrow grouping of muons. The probability that these are due to random fluctuations is less than 5%. (Australia)

8259 ARRIVAL TIME SPREAD OF MUONS IN EAS. Armitage, M.; Blake, P. R.; Ferguson, H.; Nash, W. F.; Thomas, D. W. E. (Univ. of Nottingham, Eng.). pp 1068-73 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

A 10-m^2 liquid scintillator detector was used to measure the spread in arrival times of muons sampled in EAS detected by the Haverah Park array. The mean time spread was studied as a function of shower parameters and compared with model calculations. (Australia)

8260 HEIGHTS OF ORIGIN OF MUONS IN LARGE AIR SHOWERS. Earnshaw, J. C.; Machin, A. C.; Orford, K. J.; Pickersgill, D. R.; Turver, K. E. (Durham Univ., Eng.). pp 1081-5 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Information on the heights of production of muons was obtained from: Lateral and angular separation of muons from the shower core, the geomagnetic distortion of the muon charge ratio at various points in the shower front. The mean heights of production of muons of various momenta were determined for data recorded during 1965 to 69 at Haverah Park; the experimental data are compared with model predictions based upon differing forms of shower development. (Australia)

8261 MOMENTUM SPECTRA OF MUONS AT HIGH MOMENTA IN LARGE AIR SHOWERS. Earnshaw, J. C.; Machin, A. C.; Orford, K. J.; Pickersgill, D. R.; Turver, K. E. (Durham Univ., Eng.). pp 1086-91 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The momentum resolution of the Haverah Park spectrograph was improved. The momentum spectrum of muons between 100 and 600m from the core of showers of primary energy ~10^{17} eV, measured with the new instrument, is reported. The data of this spectrum are limited statistically but there is some confirmation of that obtained previously using the unmodified spectrograph, which suggested an early development of the shower in the atmosphere, manifested by the presence of high momentum muons at large distances from the shower core. The earlier data are analyzed to show any dependence of the muon momentum spectra on shower primary energy, zenith angle, and arrival direction. (Australia)

8262 RADIO PULSES AS A RESULT OF ATMOSPHERIC ELECTRIC FIELDS. Hazen, W. E.; Hendel, A. Z. (Univ. of Michigan, Ann Arbor). pp 1127-30 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Anomalous radio pulses associated with cosmic-ray air showers were detected which are attributed to the effect of large electric fields in thunderstorms. (Australia)

8263 LATERAL DISTRIBUTION OF RADIO SIGNALS FROM COSMIC RAY AIR SHOWERS. Clay, R. W.; Hough, J. H.; Prescott, J. R. (Univ. of Calgary, Alberta). pp 1132-5 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The electric field strength at a frequency of 22 MHz was determined as a function of distance from the axis of extensive air showers of size about 10^6 particles. The distribution is steeper for core distances R less than 100 m than it is at larger distances. From 100 to 300 m it is compatible with an exponential e^{-R/R_0}. Preliminary data at 50 MHz and 120 MHz support the suggestion that the value of R_0 increases with wavelength. (Australia)

8264 LARGE DELAY-HIGH ENERGY HADRONS IN EXTENSIVE AIR SHOWERS: POSSIBLE EVIDENCE FOR HEAVY MASS

PARTICLES. Tonwar, S. C.; Naranan, S.; Sreekantan, B. V. (Tata Inst. of Fundamental Research, Bombay). pp 1171-6 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

A detailed study of the time structure of hadrons of energy >5 GeV in extensive air showers was carried out at mountain altitude of 800 gms/cm^2. The experiment has shown that about 6×10^{-3} hadrons of energy >20 GeV arrive with delays >20 ns. The calculated frequency of such events taking into account copious production of $N\bar{N}$'s is only of the order of 10^{-4}. These high energy-large delay events offer themselves as strong candidates for heavy mass particles (~10 GeV/c^2) in air showers. It is to be emphasized that the interpretation of these events in terms of heavy mass particles needs to be substantiated by further experiments incorporating visual detectors in addition to energy measuring and timing devices. The design features of a new experiment that is being planned on these lines are presented. (Australia)

8265 TIME STRUCTURE OF HADRONS IN EXTENSIVE AIR SHOWERS AND MODELS OF HIGH ENERGY INTERACTIONS. Tonwar, S. C.; Sreekantan, B. V. (Tata Inst. of Fundamental Research, Bombay). pp 1177-81 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The arrival time spectra of hadrons in the energy range 5 to 40 GeV in extensive air showers of size 6.7×10^4 to 1.8×10^6 particles were obtained in an experiment carried out at a mountain altitude of 800 gms/cm^2. Comparison of the experimentally obtained time structure with predictions based on different models of high energy interactions has shown: that in ultra high energy interactions the "isobar-pionization" type of models are preferred to pure "fire-ball" type of models, and there is considerable increase in the cross section for the production of $N\bar{N}$'s at energies $>10^{12}$ eV compared to the cross section observed at machine energies. (Australia)

8266 SEPARATION OF σ_l AND σ_t AT $q^2 \sim 1$ (GeV/c)^2 IN THE RESONANCE REGION. Alder, J. C.; Brasse, F. W.; Chazelas, E.; (and others) (DESY, Hamburg). Nucl. Phys.; B48: No. 2, 487-92(1972).

Some new values of $R = \sigma_l/\sigma_t$ taken in the resonance region from inelastic ep scattering at DESY are reported. Cross sections were measured at $\theta = 57°$ and $\theta = 15°$ to 17° at $q^2 = 1$ GeV^2. R was calculated at masses $1495 \leq W \leq 1715$ MeV. It was found that the contribution of σ_l to the total cross section is small, below 20%. The errors are less than $\Delta R = 16\%$. (auth)

8267 MEASUREMENT OF THE ASYMMETRY FOR π^+ PHOTOPRODUCTION FROM POLARIZED PROTONS BETWEEN 300 AND 900 MeV. Arai, S. (Nagoya Univ., Japan); Fukui, S.; Horikawa, N.; (and others). Nucl. Phys.; B48: No. 2, 397-414 (1972).

The asymmetry of the cross section for π^+ photoproduction from a polarized butanol target was measured at a c.m. angle 90° and photon energies between 300 and 900 MeV by a single-arm spectrometer detecting positive pions. The results indicate that the asymmetry has clear positive peaks at photon energies 400 and 700 MeV with a deep valley at about 600 MeV. The general feature of the results is well reproduced by the phenomenological analyses made by Walker and ourselves; however, the best fit to the polarized target asymmetry data seems to give a somewhat different set of parameters from that given by Walker. (auth)

8268 ELECTROMAGNETIC STRUCTURE OF THE HADRONS. Bartoli, B.; Felicetti, F.; Silvestrini, V. (CNEN, Frascati, Italy). Riv. Nuovo Cim.; 2: No. 3, 241-302(1972).

An experimental review is given of the elastic scattering of leptons on nucleons and on virtual pions, the inelastic inclusive scattering of leptons on nuclear targets, hadron–antihadron pair production from $e^+ + e^-$ interactions, and the production of multihadron systems in $e^+ + e^-$ collisions. Also reviewed is the experimental evidence for the validity of the hypothesis which allows one to express the results of experiments in terms of structure functions of the hadrons involved in the reactions. (J.F.P.)

Weak

8269 MEASUREMENT OF THE K_S^0 MEAN LIFE. Skjeggestad, O. (Univ. of Oslo); James, F.; Montanet, L.; (and others). Nucl. Phys.; B48: No. 2, 343-52(1972).

The K_S^0 mean life was measured using a sample of 50,000 $K^0 \rightarrow \pi^+\pi^-$ decays in a hydrogen bubble chamber. $\tau = (0.8958 \pm 0.0045) \times 10^{-10}$ s was obtained. This value is significantly higher than the present world average of $\tau = (0.862 \pm 0.006) \times 10^{-10}$ s. (auth)

8270 EXPERIMENTAL STUDY OF $K_0 \rightarrow \pi^+\pi^-\pi^0$ DECAYS AND SEARCH FOR CP VIOLATION. James, F. (CERN, Geneva); Montanet, L.; Paul, E.; (and others). Nucl. Phys.; B49: 1-12(1972).

The time distribution of 180 uniquely identified $\pi^+\pi^-\pi^0$ decays of the K^0 meson between 0.04 and 20 K^0 lifetimes was studied. It is found that the ratio $\eta_{\pm 0}$ of the $K_S^0 \rightarrow \pi^+\pi^-\pi^0$ to the $K_L^0 \rightarrow \pi^+\pi^-\pi^0$ amplitude is consistent with no CP violation. The results confine $\eta_{\pm 0}$ to $\sim 0 <$ Re $\eta_{\pm 0} < -2$ with small negative values of Im $\eta_{\pm 0}$. If Re $\eta_{\pm 0} = 0$ is taken, Im $\eta_{\pm 0} = 0.37^{+0.47}_{-0.34}$ is obtained. If in addition the known value of $\Gamma(K_L^0 \rightarrow \pi^+\pi^-\pi^0)$ is used, Im $\eta = -0.23^{+0.31}_{-0.25}$ is obtained. Without these restrictions, a more accurate determination of $\eta_{\pm 0}$ can only be made, with the present statistics, by a combination of K^0 and $\bar{K}^0$ data. Assuming $\eta_{\pm 0} = 0$, $\Gamma(K_L^0 \rightarrow \pi^+\pi^-\pi^0) = (2.35 \pm 0.20) \times 10^6$ s^{-1} is found. (auth)

Strong (Baryon-induced)

Refer also to abstract 8515.

8271 (LBL–1334) BACKWARD NEUTRON–PROTON SCATTERING WITH A POLARIZED TARGET. Robrish, P. R. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 68p. Dep. NTIS.

Thesis.

A description of an experiment which measured the asymmetry in the elastic scattering of neutrons from polarized protons, for incident neutron momenta of from 1.0 to 5.5 GeV/c and for final neutron scattering angles near 180° in the center-of-mass is given. The angles considered in the experiment correspond to a momentum transfer range of $0 \leq -u \leq .6$ and within this range the asymmetry was consistently negative (where the normal to the scattering plane is defined by the cross product of the initial and final neutron momentum vectors). The asymmetry could be reasonably represented by a function of the form $A(-u) = -(1/2M_p)\sqrt{-u}$ where M_p is the mass of the proton. (auth)

8272 KAON AND BARYON–ANTIBARYON PRODUCTION IN THE RANGE OF A FEW TeV PRIMARY ENERGY. Malhotra, P. K.; Raghavan, R. (Tata Inst. of Fundamental Research, Bombay). pp 1182-7 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Available emulsion data on nuclear interactions produced by neutral and charged secondary particles emitted from jets with a median primary energy of about 5 TeV were analyzed to deduce information on the proportion of kaons and baryon-antibaryons among the created particles. Using a value of $0.15^{+0.05}_{-0.02}$ for the proportion of baryon-antibaryons (charged and neutral), recently obtained by Tonwar et al., 1971, a value of $0.18^{+0.06}_{-0.07}$ is deduced for the proportion of charged and neutral kaons at primary energies in the region of 5 TeV. Kaons and baryon-antibaryons together constitute 0.33 ± 0.07 of all created particles. It is shown that the existing experimental information is consistent with these results. (Australia)

8273 PROPERTIES OF PROTON–PROTON INTERACTIONS ABOVE 100 GeV. Bussian, A. E. (Univ. of Michigan, Ann Arbor); DeMeester, G. D.; Jones, L. W.; (and others). pp 1194-9 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Final data from the Michigan–Wisconsin Echo Lake Experiment on proton-proton interactions is presented. The average charged prong multiplicity increases as the logarithm of energy, the multiplicity distributions are Poisson distributions in charged particle pairs, and the cross sections for each multiplicity channel vs. energy follow curves in agreement with these two conclusions coupled with a constant inelastic cross section. The angular distributions of prongs, presented as distributions in log tan θ, are in agreement with a Reggeized multiperipheral model. The angular distributions show evidence of some nucleon exchange and also some leading particle behavior. With moderate errors, the inelastic p-p cross section from 100 to 800 GeV is compatible with energy independence, and in qualitative agreement with values below 30 GeV. Cross sections on iron are also energy independent from the calorimeter data alone. Results from analysis of data from other targets are also discussed. (Australia)

8274 ENERGY DEPENDENCE OF CROSS SECTIONS OF COSMIC RAY NUCLEI IN TUNGSTEN. Balasubrahmanyan, V. K.; Crannell, C. J.; Hagen, F. A.; Ormes, J. F.; Ryan, M. J. (Goddard Space Flight Center, Greenbelt, Md.). pp 1207-10 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

An ionization spectrometer consisting of 12 layers of tungsten each 6.13 gm cm^{-2} thick and 7 iron modules each 70 gm cm^{-2} thick was flown in a balloon on November 14, 1970, at an altitude of 6 gm cm^{-2} for 16 hours. The distributions of the first interaction points are used to determine the mean free path of the incident particles. At energies of 20 GeV the proton m.f.p. of 140 gm cm^{-2} is in agreement with that of other workers. The m.f.p.'s of heavy nuclei were determined as a function of energy up to a total energy of 1,000 GeV. These results are compared with the overlap model of nucleus-nucleus collisions of Bradt and Peters. For C nuclei interacting with W the overlap parameter is -2.6×10^{-13} cms. The energy dependence of this parameter is discussed. (Australia)

8275 POWER-LAW ENERGY SPECTRUM DEDUCED FROM THE ANGULAR DISTRIBUTION OF NUCLEAR INTERACTIONS OF 20 TO ~10^3 GeV. Kim, C. O.; Sim, K. S. (Korea Univ., Seoul). pp 1255-60 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

As a function of $\eta(\theta)$ ($\cong 0.46 - \ln \tan \theta$), $\log_{10} F$ distributions of the forward-cone secondaries, observed in high energy nuclear interactions produced in nuclear emulsion, were found to fit well to the form of a linear function, $(\alpha\ \eta(\theta) + \gamma)$. The values of $(-\alpha)$, obtained from fitting procedures, are approximately equal to unity for nuclear interactions with a sufficient number of charged secondaries. This fact implies a power-law differential energy spectrum of production with almost the same index of power in a wide range of E_p between 20 to ~10^3 GeV. It was also concluded, from the systematic study of the 1,335 30-GeV/c proton jets, that the target nucleus in the hadron-nucleus collisions does not affect the shape of the angular distribution of the secondaries in the LS forward cone. (Australia)

8276 OBSERVED AND PREDICTED MULTIPLICITIES IN VERY HIGH ENERGY INTERACTIONS. Grieder, P. K. F. (Univ., Bern). pp 1265-70 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Recent HBC and hydrogen target multiplicity data are compared with multiplicity predictions, and with the bulk of existing data over the entire experimental energy range. Multiplicity tendencies of very high energy nucleon-nucleus interactions are also discussed. (Australia)

8277 PROTON-NUCLEON INTERACTIONS AT 14 GeV IN NUCLEAR EMULSION. Virk, H. S. (Univ., Paris). Nucl. Phys.; B48: No. 2, 476-86(1972).

A systematic study of complete identification of shower particles in jets produced by the interaction of 14 GeV protons with free or quasi-free nucleons in nuclear emulsions has been undertaken. The relative number of pions, protons, and kaons among shower particles was found to be 74 ± 7%, 17 ± 4% and 9 ± 3% respectively. Various other parameters such as multiplicity, angular distribution, momentum and energy distribution for charged secondaries have been determined and compared with the results of work at other energies. The coefficient of inelasticity is estimated to be 0.60. (auth)

8278 INCLUSIVE STUDY OF Λ^0, Σ^+ AND Σ^- HYPERONS PRODUCED IN PROTON-PROTON COLLISIONS FROM 6.6 TO 28 GeV/c. Oh, B. Y.; Smith, G. A. (Michigan State Univ., East Lansing). Nucl. Phys.; B49: 13-21(1972).

Inclusive production of Λ^0, Σ^+ and Σ^- hyperons was studied in proton-proton interactions from 6.6 to 28 GeV/c. Cross sections rise rapidly from 6.6 to 13 GeV/c. Above approximately 20 GeV/c the cross sections appear to have reached a scaling limit in the laboratory longitudinal momentum variable q_L and the c.m. Feynman variable x. There is no detectable polarization of the Λ^0 as a function of $-t$ at all energies. Laboratory production differential cross sections are presented. (auth)

827 AZIMUTHAL CORRELATIONS OF HIGH-ENERGY COLLISION PRODUCTS. Foster, M. C. (State Univ. of New York, Stony Brook); Freedman, D. Z.; Nussinov, S. Phys. Rev., D; 6: No. 11, 3135-45(1 Dec 1972).

Experimental distributions of azimuthal angles between particles produced in pp and pd collisions at 28 GeV/c and $\bar{K}p$ collisions at 9 GeV/c are presented and studied. A simple protostatistical model describes the over-all azimuthal distributions quite well. Other models are also considered. It is shown that the azimuthal distribution for reactions of fixed charged prong number may be used to estimate the average number of missing neutrals, and the distributions of a collective variable designed to test for a preferred transverse direction in multiparticle events are studied. (auth)

Strong (Meson-induced)

8280 (COO-1195-248) MASS SPECTRA OF THE f-ZERO AND A2-ZERO MESONS IN THE REACTIONS PI-MINUS PROTON GOES TO NEUTRON PI-PLUS PI-MINUS AND PI-MINUS PROTON GOES TO NEUTRON RHO PI AT 4.5 GeV/c. Jordan, Michael (Illinois Univ., Urbana). Oct 1972. Contract AT(11-1)-1195. 97p. Dep. NTIS.

An experiment was performed to study the mass spectra of the f^0 and A_2^0 mesons in the reactions $\pi^- p \to n\pi^+\pi^-$ and $\pi^- p \to n\pi^+\pi^-\gamma\gamma$ with an incident pion momentum of 4.5 GeV/c using scintillation counters and optical spark chambers. The mass resolution was verified by measuring the width of the ω^0 meson. The mass spectra of both resonances were fit well by a simple Breit-Wigner shape. For the f^0 meson the Breit-Wigner shape was definitely favored over a dipole shape with confidence levels of 92% and 5.4% respectively. (auth)

8281 (COO-2090-1) EXPERIMENTAL PARTICLE PHYSICS PROGRAM. Final Report. Nussbaum, Mirko M. (Cincinnati Univ., Ohio. Dept. of Physics). 1972. Contract AT(11-1)-2090. 82p. Dep. NTIS.

Experimental research on strong interactions is summarized. (J.F.P.)

8282 STUDY OF DAUGHTER STATE UNDER K*(890). Chung, S. U.; Eisner, R. L.; Aguilar-Benitez, M. (Brookhaven National Lab., Upton, NY). Phys. Rev. Lett.; 29: No. 23, 1570-3(4 Dec 1972).

The region of K*(890) is analyzed in terms of s and p waves, using a formula for the mass-dependent angular distributions and imposing the positivity conditions on the full density matrix which includes the s-p interference effect. From this analysis it is shown that, independent of the production dynamics, the experimental data can accommodate little, if any, narrow-width s-wave state in the K*(890) region. (auth)

8283 KINEMATIC CHARACTERISTICS OF RESIDUAL NUCLEI DURING THE INTERACTION OF π-MESONS WITH ENERGIES OF 45 AND 60 GeV WITH HEAVY NUCLEI IN AN EMULSION. Azimov, S. A.; Aripov, R.; Gulyamov, U. G.; Lozhkin, O. V. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad, Nauk Uzb. SSR; No. 8, 22-4(1971). (In Russian).

Nucleus recoil was observed in the splitting of heavy nuclei (AgBr) of photographic emulsion, accompanied by ^{8}Li fragments. The emulsion was irradiated by a beam of 45- and 60-GeV π^--mesons from an accelerator. The angular distribution of nucleus residues from the splitting with ^{8}Li fragments was measured, and was found to depend on several factors, such as the direction of flight of these multi-charged particles. (K.S.W.)

8284 REACTION $\pi^- p \to p\pi^+\pi^-\pi^-\pi^0$ AT 20 GeV/c. Sisterson, L. K.; Harrison, W. C.; Heyda, D.; (and others) (Harvard Univ., Cambridge, MA). Nucl. Phys.; B48: No. 2, 493-518(1972).

Data from the reaction $\pi^- p \to p\pi^+\pi^-\pi^-\pi^0$ at 20 GeV/c are studied in detail. The cross sections for the production of ρ, η^0, and ω^0 mesons, and $\Delta(1236)$ isobars are estimated. The channels $p\eta^0\pi^-$ and $p\omega^0\pi^-$ are compared with a double Regge pole model calculation and the cross section for the contribution from individual diagrams calculated. The data are divided by the method of longitudinal phase space and each category examined in detail. A search is made for possible production of ρ^- (1700), A_1^0 and A_2^0 and upper limits placed on their cross sections. (auth)

8285 ANALYSIS OF THE REACTION $K^+p \to Q^+p$ FROM 2.5 TO 12.7 GeV/c. Bingham, H. H. (CERN, Geneva); Eisenstein, L.; Goldschmidt-Clermont, Y.; (and others). Nucl. Phys.; B48: No. 2, 589-620(1972).

The Q-region of $K\pi\pi$ mass (i.e., $1.10 \leq M(K\pi\pi) < 1.5$ GeV) is studied for the reactions $K^+p \to K^+\pi^+\pi^-p$ (≈77,000 events) and $K^+p \to K^0_{seen}\pi^+\pi^0p$ (≈19,000 events). The data samples correspond to K^+p interactions at fourteen beam momenta in the range 2.5 to 1 .7 GeV/c. The production and the decay of the $K\pi\pi$ system are analyzed as a function of the incident energy and the $K\pi\pi$ mass. It is shown that the differential cross section $d\sigma/dt_{pp}$

shrinks when the incident energy increases. The spin-parity is found to be predominantly 1^+ for the whole Q-region and the density-matrix elements do not vary with the energy or the $K\pi\pi$ mass. The ratio of the number of $K\rho$ to the number of $K^*\pi$ events is obtained from a fit of the decay Dalitz plot and found to be maximum for $1.25 \leq M(K\pi\pi) < 1.30$ GeV. (auth)

8286 SPARK CHAMBER EXPERIMENT ON THE REACTION $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ AT 3.1 TO 3.6 GeV/c. Whitehead, C. (Atomic Energy Research Establishment, Harwell, Eng.); West, D.; Bird, L.; (and others). Nucl. Phys.; B48: No. 2, 365-91(1972).

A spark chamber experiment was performed at the Rutherford Laboratory to study the reactions $\pi^-p \rightarrow n\pi^+\pi^-$, nK^+K^-, and n^+ (all neutrals) over the momentum range 3.1 to 3.6 GeV/c. The experimental arrangement restricted measurements to small momentum transfers. Over the missing mass range 1.0 to 1.5 GeV/c^2 (mass resolution ±15 to ±30 MeV/c^2) the angular distribution of charged two-body decays was measured. Analysis of the angular distributions by fitting to Legendre polynomials shows enhancement of S-wave as well as D-wave at the f^0 mass. A number of K^+K^- decay events were observed but these did not exhibit a peak at the f^0 mass. These events yielded an upper limit of 2% for the $K\bar{K}/\pi\pi$ branching ratio at 85% confidence level. (auth)

8287 BEHAVIOUR IN TERMS OF ANGULAR VARIABLES OF THE INCLUSIVE REACTIONS $K^+p \rightarrow K^0X^{++}$ AND $K^+p \rightarrow K^0\pi^+X^+$ AT 5.0 AND 8.2 GeV/c. Chliapnikov, P. V. (CERN, Geneva); Ciapetti, G.; Drijard, D.; (and others). Nucl. Phys.; B48: No. 2, 429-45(1972).

The inclusive reactions $K^+p \rightarrow K^0 + X^{++}$ at 5.0 and 8.2 GeV/c and $K^+p \rightarrow K^0 + \pi^+ + X^+$ at 8.2 GeV/c are analyzed in terms of angular variables θ and ϕ. The data are compared and found consistent with various theoretical bounds on the s-dependence of the inclusive reaction cross sections. Experimental evidence is presented that $d\sigma/d\cos\theta = a \exp(-b \sin\theta)$ with $b \sim \sqrt{s}$ and a increasing with energy. Correlations between the angular variables and between the variable ϕ and the K^0 and π^+ momenta in the c.m.s. are observed and discussed. (auth)

8288 MEASUREMENT OF THE COMPLETE SPIN DENSITY MATRIX OF THE Y*(1385) IN 8 GeV/c π^+p AND 10 GeV/c K^-p INTERACTIONS AND COMPARISON WITH QUARK MODEL PREDICTIONS. Aachen-Berlin-CERN-Cracow-London-Vienna-Warsaw Collaboration. Nucl. Phys.; B49: 405-12(1972).

Parity conserving decays yield incomplete information about the spin state of a decaying resonance. Using the cascade decay $Y^*(1385) \rightarrow \Lambda\pi$ ($\Lambda \rightarrow p\pi$), where the second decay does not conserve parity, all the parameters necessary to specify the spin state of Y* resonances are found. Y* resonances produced in π^-p reactions at 8 GeV/c and K^-p reactions at 10 GeV/c are studied. It is found that the experimental results are, with one exception, in reasonable agreement with the predictions of the additive quark model. (auth)

8289 VIOLATION OF BOTH S- AND t-CHANNEL HELICITY CONSERVATION FROM AN LPS ANALYSIS OF DIFFRACTION DISSOCIATION IN $\pi p \rightarrow \pi\pi\pi p$. Aachen-Berlin-Bonn-CERN-Heidelberg Collaboration. Nucl. Phys.; B49: 441-57(1972).

Conservation of helicity in the s- and t-channels was investigated for the dissociation processes $\pi^\pm \rightarrow (\pi^\pm\pi^-\pi^+)$ and $p \rightarrow (p\pi^\pm\pi^-)$ in $\pi^-p \rightarrow \pi^-\pi^-\pi^+p$ at 16 GeV/c and $\pi^+p \rightarrow \pi^+\pi^+\pi^-p$ at 8 and 16 GeV/c. The method used consists of studying the modifications in the event distribution in longitudinal phase space (LPS), under rotation of all events around the z-axis in the helicity (s-channel) and Gottfried–Jackson (t-channel) frames. Strong violation of s-channel helicity conservation is confirmed. A small, but systematic, violation of t-channel helicity conservation is found for low (3π) masses, but it does not seem present in the ($p\pi^+\pi^-$) dissociation. It is found experimentally that the violation is such that if the angular distribution of the decay particles were studied, this violation could be detected only when the "beam-unlike" pion is used as the analyzer, the other analyzers averaging out the effect. (auth)

8290 HIGHER-MASS BOSONS FROM 7.87-GeV/c π^+d INTERACTIONS. Bugg, W. M. (Univ. of Tennessee, Knoxville); Condo, G. T.; Hart, E. L.; (and others). Phys. Rev., D; 6: No. 11, 3047-50(1 Dec 1972).

By employing the 80-in. BNL deuterium bubble chamber as a missing-mass spectrometer, evidence for an odd-G-parity state with a mass in the T region (2.1–2.4 GeV/c^2) is presented. Indications from the individual channels suggest that it has, at most, a marginal amplitude for decay into $\rho\rho\pi$. (auth)

8291 ASYMMETRY PROPERTIES OF LONGITUDINAL-MOMENTUM DISTRIBUTIONS FOR THE REACTION $\pi^+p \rightarrow p8\pi$ AT 11 GeV/c. Yost, G. P.; Morris, W. A.; Albright, J. R.; Lannutti, J. E. (Florida State Univ., Tallahassee). Phys. Rev., D; 6: No. 11, 30501-8(1 Dec 1972).

Data are presented for the deeply inelastic high-multiplicity exclusive reaction $\pi^+p \rightarrow p4\pi^+3\pi^-\pi^0$ at 11 GeV/c. It is shown that asymmetry moments of the longitudinal-momentum distributions of the final-state particles can be interpreted qualitatively in terms of the additive quark model, but that some contribution from double scattering or more complex interactions may be indicated. It is shown also that similar results can be obtained from models not involving quarks. Specific cases of the Zieminski F(t) model and the Chanloskiewicz-Allison model are discussed. (auth)

8292 η' PRODUCTION IN π^+d INTERACTIONS FROM THRESHOLD TO 2.4 GeV/c. Rader, R. K.; Abolins, M. A.; Dahl, O. I.; (and others) (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 11, 3059-68(1 Dec 1972).

A study was made of η' production using a π^+ beam incident on deuterium in the 72-in. bubble chamber, with beam momenta from 1.1 to 2.4 GeV/c. Cross sections for reactions leading to five- and six-pronged final states are presented. η' production was observed in the reaction $\pi^+d \rightarrow pp\eta'$, with the decay mode $\eta' \rightarrow \pi^+\pi^-\eta$. The cross section for $\pi^+n \rightarrow p\eta'$ (studied in the impulse approximation) is observed to rise to a maximum of about 100 μb at 2.2-GeV c.m. energy. The production angular distribution develops peripheral peaking with increasing energy. (auth)

8293 PROPERTIES OF $^4_\Lambda$He. Fetkovich, J. G. (Carnegie-Mellon Univ., Pittsburgh); McKenzie, J.; Riley, B. R.; (and others). Phys. Rev., D; 6: No. 11, 3069-85(1 Dec 1972).

In a study of the interactions of stopped negative kaons in a helium bubble chamber, production and decay branching ratios of $_\Lambda He^4$ were measured. Relative decay branching ratios agree with earlier results but the production fraction is nearly a factor of two less than the previous measurement. The binding energy of $_\Lambda He^4$ was determined from both production and decay reactions. The relationship of the difference between these two binding-energy results to the recent observation of an excited state in $_\Lambda He^4$ or $_\Lambda H^4$ at 1.09 MeV and the $\bar{K}\Lambda$ parity is discussed. (auth)

8294 INVESTIGATION OF g-MESON MASS REGION UTILIZING HIGH-ENERGY K^+p COLLISIONS. Holmes, R.; Ferbel, T.; Slattery, P.; Werner, B. (Univ. of Rochester, NY). Phys. Rev., D; 6: No. 11, 3336-8(1 Dec 1972).

A result previously reported at 10 GeV/c, namely the production of a four-pion resonance at ~1630 MeV with a width of ~125 MeV in the reaction $K^+p \rightarrow K^0p\pi^+\pi^+\pi^-\pi^0$, is confirmed at 12.7 GeV. No corresponding two-pion enhancement is observed in the reaction $K^+p \rightarrow K^0p\pi^+\pi^0$. (auth)

8295 PRODUCTION OF CHARGED PIONS BY 730-MeV PROTONS FROM HYDROGEN AND SELECTED NUCLEI. Cochran, D. R. F.; Dean, P. N.; Gram, P. A. M.; (and others) (Los Alamos Scientific Lab., NM). Phys. Rev., D; 6: No. 11, 3085-3116(1 Dec 1972).

An experiment was done in the external proton beam of the Berkeley 184-in. cyclotron to measure the production cross sections for pions from various target nuclei, from hydrogen to lead. The cross-section data are presented and the reaction mechanisms discussed. The hydrogen production appears to fit the one-pion-exchange model. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstracts 8674, 8677, and 8682.

General

8296 (COO–3533-6) SCATTERING OF PARTICLES WITH SPIN; MACKY STATE FORMULATION. Balachandran, A. P.; Nilsson, J.; O'Raifeartaigh, L. (Goterbourg Univ. (Sweden). Inst. of Theoretical Physics). 1970. 31p. (SU–4205-6). Dep. NTIS.

The conventional states used to describe the scattering of particles with spin are the covariant states and the Wigner states. The scattering of massive particles is described in terms of Mackey states, which are analogous to the states used by Mackey in his induced theory of group representations, and whose advantage is that their Lorentz transformation law does not involve the spin indices explicitly. The description with Mackey states follows the pattern of the description in the well known papers of Jacob and Wick and of Trueman and Wick and covers in particular partial-wave analyses, discrete symmetries and crossing. It is hoped that the usefulness and elegance of the Mackey states become evident in the course of the discussion. (auth)

8297 (JINR–E2-6653) GEOMETRY AND PHYSICS OF THE MICROWORLD. Blokhintsev, D. I. (Joint Inst. for Nu-

clear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 36p. Dep. NTIS (U. S. Sales Only).

An essay is presented on problems arising as a result of the transfer of geometric notions from classical physics to the world of elementary particles. (auth)

8298 SPECTRUM OF THE MASSES OF ELEMENTARY PARTICLES AND CONSTANTS OF WEAK INTERACTION. Kropotkin, P. N. (Geological Inst., Moscow). Dokl. Akad. Nauk SSR; 206: No. 2, 304-6(11 Sep 1972). (In Russian).

Dirac's postulate that the known dimensionless constants are either grouped in the range 10^0 to 10^4, or else are of the order of 10^{40} is restated to include three groups: 10^{40} to 10^{80}, expressible in terms of β ($=e^2/Gm^2 = 4.17 \times 10^{42}$); 10^2 to 10^7 (such as the magnetic moment of the electron); and numerical coefficients, 10^0 to 10^1, apt to be simple geometric ratios such as mass pion/mass muon = −.99 ($4/3$), proton/pion = 6.7 = 1.05 (2π), etc. These are elaborated, and related to the "spectrum" of lifetimes of unstable particles (neutrons, mesons). (K.S.W.)

8299 METHOD FOR DETERMINING FIRE BALL SPIN. Iida, S.; Muraki, Y. (Nagoya Univ., Japan). pp 1224-8 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

The angular distribution of the decay products from the higher spin particles is presented. The calculation is performed numerically under the assumption that the matrix element is represented by the overlap of each wave function of the neutral pions and under the consideration of the conservation law of the parity, the angular momentum and the azimuthal angular momentum. Also the Bose−Einstein statistics between the emitted four π_0 and the simplified phase volume are taken into consideration. (Australia)

8300 DISCONTINUITIES ACROSS BRANCH CUTS IN THE ANGULAR MOMENTUM PLANE. Abarbanel, H. D. I. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 6: No. 10, 2788-2805(15 Nov 1972).

Integral equations for coupled-particle and Reggeon partial-wave amplitudes are presented. A construction of these equations proceeds from the unitarity relation using the notion of two-Reggeon irreducibility. From these equations, which are approximate matrix elements of a Lippmann−Schwinger equation in two-dimensional nonrelativistic quantum mechanics, it is demonstrated that the discontinuity across the two-Reggeon cut in particle scattering is equal to an integral over Reggeon-particle absorptive parts actually measurable in single-particle inclusive reactions. This provides one with a handle on the magnitude of Regge cuts. Finally a little model of coupled Reggeon and particle "states" is made, and the allowed partial-wave amplitudes are solved for when a pole and a two-Reggeon cut are close by. This has clear relevance for the physics of diffraction scattering near $l = 1$ and $t = 0$. (auth)

8301 SPONTANEOUSLY BROKEN GAUGE SYMMETRY AND ELEMENTARY PARTICLE MASSES. Georgi, H.; Glashow, S. L. (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 6: No. 10, 2977-82(15 Nov 1972).

There are a number of approximate relations among elementary particle masses. In conventional theories, these are explained by assuming a hierarchy of interactions with the property that the stronger interactions have the more extensive symmetry. In renormalizable theories based on spontaneously broken gauge symmetry, this view is untenable. Manifest breaking of the gauge symmetry would destroy the renormalizability. The possible origin of approximate mass formulas in theories of this kind is explored. (auth)

8302 ANALYTIC STRUCTURE OF MULTIPARTICLE AMPLITUDES IN COMPLEX HELICITY. Abarbanel, H. D. I.; Schwimmer, A. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev., D; 6: No. 10, 3018-31(15 Nov 1972).

By studying the partial-wave expansions of multiparticle amplitudes it is argued that analytic properties in complex helicity are just a reflection of the familiar analytic structure in angular momentum. A criterion is given which determines when an asymptotic behavior in an azimuthal angle (conjugate to the helicity) can be reached in a physical process. The discussion centers around the five- and six-point functions; the latter, being relevant for single-particle inclusive processes, is considered in detail. One of the interesting features of analytic structure in λ is that it depends in detail on what other variables one chooses in addition to the azimuthal angle conjugate to it. That singularity structure is found by examining the partial-wave analysis appropriate to the chosen variables. Finally, a discussion of signature in many-particle amplitudes is given. (auth)

8303 ALGEBRA OF FIELDS ON THE LIGHT CONE. Feinberg, F. L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 6: No. 10, 2852-74(15 Nov 1972).

A consistent light-cone formulation of the algebra of fields is derived by the use of Schwinger's quantum action principle. The current commutators are extracted from the theory for a massive Yang−Mills field interacting with fermions by an invariant coupling. Deep-inelastic scaling sum rules are found which are formally valid and which relate $F_2(w)$ [$= F_L(w)$] to the Fourier transform of the diagonal matrix elements of a bilocal operator. In addition, fixed-mass sum rules (valid if Class-II graphs do not contribute) are derived. These relate integrals of various structure functions to the bilocal operator mentioned above. In the Born approximation these fixed-mass sum rules are not valid, except at the physically interesting point $q^2 = 0$. (auth)

8304 OPERATOR DROPLET MODEL AT FINITE MOMENTA. Harrington, D. R. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 6: No. 10, 2900-5(15 Nov 1972).

The operator droplet model at finite momenta is discussed, using an infinite set of generalized s-channel ladder graphs. The model is shown to follow from the assumption that the centers of mass of the scattering systems move with constant velocities. The conditions for the validity of this assumption are investigated and shown to be closely related to the conditions for the validity of Glauber theory for the nonrelativistic scattering of composite systems. (auth)

8305 MULTI-REGGE EXPANSIONS, THE GENERALIZED OPTICAL THEOREM, AND INCLUSIVE REACTIONS. Wang, K. H. (Pennsylvania State Univ., University Park). Phys. Rev., D; 6: No. 10, 2906-12(15 Nov 1972).

A prescription is suggested to derive multi-Regge expansions for all possible coupling schemes (configuration diagrams). This prescription overcomes a difficulty caused by the breakdown of dimensionality constraints, and can be applied to general production processes. It is also shown that some criterion is needed to eliminate unwanted coupling schemes which give rise to the violation of the Froissart bound. Inclusive reactions with multi-Regge expansions are studied through the generalized optical theorem, and it is illustrated how these coupling schemes cause the violation. This might shed some light on the problem of how to eliminate unwanted schemes in multi-Regge expansions. (auth)

8306 SINGULARITIES IN COMPLEX ANGULAR MOMENTUM AND HELICITY. Weis, J. H. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 6: No. 10, 2823-41(15 Nov 1972).

Simple representations of multiparticle amplitudes are proposed which are hoped will be useful in working out the implications of Regge asymptotic behavior in practical applications. These generalized Sommerfeld−Watson transforms are integrals over complex angular momentum and helicity. The various types of singularities in complex angular momentum and helicity and the asymptotic limits of multiparticle amplitudes which they will determine are discussed. Regge-pole and Regge-cut singularities in the angular momentum plane are discussed, the concept of wrong-signature-nonsense fixed poles is generalized to multiparticle amplitudes. It is found that the absence of simultaneous discontinuities in overlapping channel invariants in the physical region requires that the relevant singularities in complex helicity be completely determined by the singularities in complex angular momentum. Therefore the only truly dynamical singularities are those in complex angular momentum. (auth)

8307 RELATION BETWEEN THE CONVERGENCE FUNCTION AND THE ELECTROMAGNETIC FORM FACTOR IN A COMPOSITE MODEL. Andriambololona, Raoelina (Madagascar Univ., Tananarive); Bourrely, C. Ann. Inst. Henri Poincare, Sect. A; 16: No. 4, 247-63(1972).

A convergence function F is introduced in a Fermi theory (self interacting nucleon antinucleon fields) in order to have a free divergency theory. The properties of the convergence function are studied. The structure functions of elementary and composite particles are calculated in terms of the convergence function F. The relation between F and the Dirac charge form factor G of the nucleon is derived in the time like region. The possibility of equating F and G is investigated and some implications of the assumption F = G are given (for instance, the universality of the form factor of mesons and nucleons in the time like region is obtained). (France)

8308 CLASS OF REPRESENTATIONS OF THE BILOCAL CURRENT ALGEBRA ON A LIGHT-LIKE RAY. Minkowski, P. (CERN, Geneva). Nucl. Phys.; B49: 22-8(1972).

A class of representations of the algebra of bilocal currents on a plane perpendicular to a light-like ray is constructed. The saturation of these representations with states of definite momenta

conjugate to the configuration space variables on the light-like plane reveals a Fock-space nature of the representation space, generated by quark and anti-quark fields obeying Fermi statistics, projected on the characteristic light-like ray. The mass spectrum, however, is not determined by the algebra. Representations on a subspace of the constructed Fock space are discussed for special momentum configurations. (auth)

8309 APPROXIMATION TO THE MASS DISTRIBUTIONS OF A SYSTEM IN A MULTIPRODUCTION FINAL STATE WITH RESONANCES. Alonso, J. L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Cruz, A. Nucl. Phys.; B49: 475-88(1972).

A method for the calculation of mass distributions in multiproduction, when a resonance is present in the final state, is proposed. The method provides a reduction of about 90% of the computation time as compared to the usual Monte Carlo methods, the time being independent on the number n of particles in the final state, there being no limitation on n. Both these circumstances are in sharp contrast with those prevailing in the Monte Carlo type calculations. (auth)

8310 MULTIPLE COUNTING IN THE EXPERIMENTAL MEASUREMENT OF DIFFRACTIVE DISSOCIATION. Chew, G. F.; Ellis, S. D. (National Accelerator Lab., Batavia, IL). Phys. Rev., D; 6: No. 11, 3330-2(1 Dec 1972).

An experimentally measurable distribution function which serves to define double as well as single diffractive dissociation and yet avoids problems with multiple counting is defined and discussed. (auth)

8311 EXTENSION OF BOUNDARY DISPERSION RELATIONS. Hite, G. E. (Univ. of Kaiserslautern, Ger.); Jacob, R. J.; Steiner, Frank. Phys. Rev., D; 6: No. 11, 3333-5(1 Dec 1972).

By introducing a variable corresponding to the Leader-Pennington variable, dispersion relations are written which are an extension of boundary dispersion relations to the interior of the physical regions. (auth)

Electromagnetic

Refer also to abstracts 8251, 8438, and 8458.

8312 (BNL-17276) INELASTIC ELECTRON SCATTERING EXPERIMENT AT ISABELLE. White, D. H. (Brookhaven National Lab., Upton, N. Y.). 28 Sep 1972. 6p. Dep. NTIS.

A proposed experiment on inelastic e + p scattering at Isabelle is described. The experiment is designed to yield a large number of events in a q^2 region greater than 10 GeV and a total energy squared in the cm of the virtual photon-proton system from 1000 to 3000 GeV. The intent would be to measure the momenta of the electron and proton in coincidence and infer the mass and momentum distribution of the missing hadronic state. (J.F.P.)

8313 (CONF-710974-3) EXPERIMENTS WITH ELECTRON-ELECTRON AND ELECTRON-POSITRON COLLIDING BEAMS. Haissinski, J. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). [1971]. 111p. Dep. NTIS (U. S. Sales Only).

From Autumn conference on high energy physics; Hamburg, Germany (13 Sep 1971).

In recent years high energy physics with e^-e^- and e^-e^+ colliding beam rings has developed very rapidly. The number of theoretical and experimental results which belong to this field is such that a selection had to be made for this short series of lectures. Although the emphasis of the survey has been put on the experiments, even some of them had to be omitted in order to give a better account of what seem to be the most characteristic aspects of the field. (auth)

8314 (JINR-D2-6735) CAUSALITY OF THE INVARIANT FORM-FACTORS (NONDIAGONAL CASE). Bogolubov, P. N.; Matveev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 14p. Dep. NTIS (U. S. Sales Only).

The causality of the invariant form factors in the expansion of nondiagonal matrix elements of the current commutators is proved. (auth)

8315 DEPENDENCE OF DOPPLER SHIFT ON PHOTON REST MASS. Lee, A. R.; Liesegang, J. (Univ. of La Trobe, Bundoora, Australia). Nature (London) Phys. Sci.; 240: No. 98, 41(13 Nov 1972).

Goldhaber and Nieto (Rev. Mod. Phys. 43: 227(1971)) have reviewed the methods that have been used in an attempt to establish an upper limit for the photon rest mass, and at present the lowest upper limit obtained experimentally is $\mu_0 \leq 4 \times 10^{-48}$ g. Suggestions were made for methods whereby an improved upper limit may be determined, and a novel method is here described based on a departure from the conventional Doppler shift for photons. The method presents experimental difficulties, involving the production and measurement of low electromagnetic frequencies to a high degree of accuracy. An advantage of the Doppler frequency technique over time dispersion wave-length experiments is that the frequency is independent of the propagation medium and is not masked by plasma dispersion and similar effects. (UK)

8316 LIMITED KINETIC ENERGY OF THE RELATIVISTIC CHARGED PARTICLE. Popov, I. L. Dokl. Akad. Nauk Tadzh. SSR; 15: No. 6, 28(1972). (In Russian).

The kinetic energy of a charged particle moving with a velocity approaching that of light is shown to have a limiting value $E < 3.7 \times 10^{27}$ eV. (K.S.W.)

8317 DEPENDENCE OF AIR SHOWER PARTICLE SPECTRA ON HIGH ENERGY INTERACTION MODELS AS DERIVED FROM SIMULATIONS. PART I. MODELS AND GENERAL PROPERTIES OF PARTICLE SPECTRA. Grieder, P. K. F. (Univ., Bern). pp 970-5 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

A large scale air shower simulation project is briefly described, including several highly detailed shower models which were used. The general properties of particle spectra obtained for the different models are discussed, and energy spectra are presented for 10^7-GeV proton-initiated showers. (Australia)

8318 DEPENDENCE OF AIR SHOWER PARTICLE SPECTRA ON HIGH ENERGY INTERACTION MODELS AS DERIVED FROM SIMULATIONS. PART II. COMPARISON WITH EXPERIMENTAL DATA AND OTHER SIMULATIONS. Grieder, P. K. F. (Univ., Bern). pp 976-81 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3)

The results of extensive simulations as described in part I are compared with experimental data. It is shown that models which imply a faster rising multiplicity-energy dependence yield spectra that are in better agreement with experimental data. A comparison with spectra from simulations carried out by other authors is also included. (Australia)

8319 SIMULATION OF EXTENSIVE AIR SHOWERS WITH ENERGY 10^{17} TO 10^{20} eV. Goorevich, L. (Univ. of Sydney). pp 983-8 of 12th International Conference on Cosmic Rays, Vol. 3, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

A one-dimensional Monte Carlo simulation was used to predict the observable properties of EAS above 10^8 GeV. The dependence of N_μ and N_e on primary energy and zenith angle was calculated for proton and copper primaries and two interaction models. Derived muon energy spectra highlight a deficiency of the models and suggest a method for correcting it. (Australia)

8320 CALCULATED DENSITY DISTRIBUTIONS OF PARTICLES IN AIR SHOWERS, AND THEIR SENSITIVITY TO PRIMARY MASS AND ASSUMED INTERACTION CHARACTERISTICS. Hillas, A. M.; Hollows, J. D.; Hunter, H. W.; Marsden, D. J. (Univ. of Leeds, Eng.). pp 1007-12 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.3).

Lateral distributions of particles in air showers at axial distances up to 1.5 km were calculated for several models of nuclear interaction, giving a wide range of possible results for shower age and proportion of muons. The primary mass can thus not be deduced from such data as yet but a change of mass with energy, if fairly rapid, should be clear. A useful form for presenting data on the proportion of muons in showers is suggested. (Australia)

8321 COHERENT PRODUCTION IN EAS. Wdowczyk, J. (Inst. of Nuclear Research, Lodz, Poland); Wolfendale, A. W. pp 1093-5 of 12th International Conference on Cosmic Rays, Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 3).

Results from nuclear emulsion studies indicate a comparatively large cross section (e.g. 1.6 mb/nucleon at 200 GeV) for coherent

interactions in which close groups of pions are produced in pion–nucleus interactions. These results, and their extrapolation to higher energies, were used to estimate the expected frequencies of groups of muons in extensive air showers for various threshold energies. The frequencies are of the same order as those of the detected "muon bundles" and there is thus the possibility of the explanation of at least some of the bundles in this way. (Australia)

8322 NUMERICAL MODEL OF THE RELAXATION OF A BEAM OF CHARGED PARTICLES IN A STRONG ELECTRIC FIELD. Alekseev, B. V.; Yanovskii, V. R. Zh. Vychisl. Mat. i Mat. Fiz.; 12: No. 4, 1053-60(1972). (In Russian).

The method of numerical model simulation is proposed for the relaxation of a beam of charged particles in a strong electric field. The field was assumed homogeneous and constant, and the concentration of charged particles was taken sufficiently small that mutual interaction was neglected. A numerical solution was found for the case in which the masses of the charged and neutral particles were comparable, and also in the presence of elastic collisions. (tr-auth)

8323 ORDER PARAMETERS IN A MULTI-PARTON THEORY. Knoth, Artur (Centro Brasileiro de Pesquisas Fisica, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 18: No. 18, 229-44(1972).

A multi-parton model with spin one-half partons is proposed. Clusterization similar to that contained in model by Kenneth Wilson is assumed. Predictions are made about the nature of the clusters using experimental data. The method of order parameters and their corresponding correlation functions is applied to the case of deep inelastic electron–proton scattering yielding information about clusterization in the proton. An introduction is given to the model. The theory is thus fairly qualitative. (tr-auth)

8324 ELECTROMAGNETIC RADIATION IN A MOVING MEDIUM. Alekseev, A. I.; Nikitin, Yu. P. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1194-7(Oct 1972). (In Russian).

The intensity of the radiation emitted by an arbitrary source in an infinite medium moving with a velocity exceeding that of light is determined. All types of waves propagating in a moving medium are considered. Drag of light by the medium, when the latter moves with a velocity exceeding that of light, is taken into account. (auth)

8325 TRIPLET FORMATION BY POLARIZED PHOTONS. Vinokurov, E. A.; Kuraev, E. A. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1142-50(Oct 1972). (In Russian).

The differential cross section with respect to azimuth angle for triplet production by a linearly polarized photon $d\sigma/d\varphi$ is determined for extremely high photon energies in the laboratory system. The cross section takes into account all cases of triplet production involving recoil electron momenta q exceeding a certain quantity q_0. In the case of an unpolarized electron the recoil electron momentum distribution is the same as that predicted by the Suh–Bethe formulas. The distribution in azimuthal angles in which all recoil electron momenta are taken into account is identical to that previously derived by Boldyshev et al. The distribution with respect to polar angle of recoil electron emission is discussed. The expression obtained for $d\sigma/d\varphi$ can be employed for determining the degree of linear polarization of a photon beam in experiments with track instruments. (auth)

8326 ELECTRON–POSITRON PAIR PRODUCTION BY A COULOMB CENTER LOCATED IN A CONSTANT FIELD. Narozhnyi, N. B.; Nikishov, A. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1135-41(Oct 1972). (In Russian).

The probability for electron-positron pair production by superposition of a Coulomb field and a constant crossed (E = H, EH = 0) field is determined. The crossed field is taken into account exactly and the Coulomb field in the first Born approximation. Although each of the fields alone does not produce pairs (Z of the Coulomb field is assumed to be $\ll 137$), superposition of the fields results in considerable production providing the crossed field strength $E \gtrsim m^2c^3/\hbar e$. (auth)

8327 MELLIN-TRANSFORM ANALYSIS OF LIGHT-CONE STRUCTURE AND SCALING IN INELASTIC ELECTRON SCATTERING. Bhaumik, D.; Greenberg, O. W.; Mohapatra, R. N. (Univ. of Maryland, College Park). Phys. Rev., D; 6: No. 10, 2989-97(15 Nov 1972).

Light-cone singularities in the current-commutator matrix element of the nucleon and scaling behavior of the structure function are characterized in terms of the singularities of the Mellin transform $\Phi(u, s)$ of the relevant Jost–Lehmann weight. Absence of singularities in $\Phi(u, s)$ for Res ≤ 1 is shown under some assumptions, to characterize the existence of the scaling limit. For Res < 2, either the left-most singularity of $\Phi(u, s)$ in the s plane or the canonical singularity at $s = 1$ determines both the leading light-cone singularity of the matrix element and the leading behavior, for large ν and Q^2 with fixed scaling variable, of the structure function. Thus the leading light-cone singularity dominator the leading behavior of the structure function regardless of the existence of the scaling limit. The contributions of x-space singularities of type $\delta(x^2-a^2)$, $a^2 > 0$, are proved to decrease in the scaling limit as ν^{-1} relative to contributions of $\delta(x^2)$ singularities. (auth)

8328 RECIPROCAL BOOTSTRAP ON THE LIGHT CONE. Zee, A. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 6: No. 10, 3011-17(15 Nov 1972).

Dynamical considerations are introduced onto the light cone in the form of the static bootstrap. One obtains (1) the prediction that the asymmetry in the deep inelastic electron scattering on polarized deuteron targets is small, and (2) a relation between $F_2^{ep} + F_2^{en}$, F_2^{ep}, and F_2^{en}. The "physical origin" of these results is discussed. The result (2) also follows as a "chiral-limit theorem." (auth)

8329 GENERALIZED RENORMALIZABLE GAUGE FORMULATION OF SPONTANEOUSLY BROKEN GAUGE THEORIES. Fujikawa, K. (Univ. of Chicago); Lee, B. W.; Sanda, A. I. Phys. Rev., D; 6: No. 10, 2923-43(15 Nov 1972).

The spontaneously broken gauge theory is formulated in the generalized renormalizable gauge (R_ξ gauge). A parameter ξ can be adjusted to include existing gauges, U gauge, R gauge, and 't Hooft–Feynman gauge as special cases. Three applications of the R_ξ-gauge formulation are given. First, one computes the weak correction to the muon magnetic moment unambiguously in the existing models for leptons. Secondly, the large-momentum-transfer limit of the Pauli magnetic form factor of the muon is discussed. Finally, the static charge of the neutrino is discussed, and it is shown that an appropriate regularization makes it vanish. (auth)

8330 COMMENT ON THE NEW EQUATION OF MOTION FOR CLASSICAL CHARGED PARTICLES. Shen, C. S. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 6: No. 10, 3039-40(15 Nov 1972).

The new equation of motion proposed by Mo and Papas is solved exactly for the case of a charge moving in a constant magnetic field. It is shown that within the realm of classical electrodynamics the new equation gives the same observable results as that of the Lorentz–Dirac equation. (auth)

8331 MAGNETIC BREMSSTRAHLUNG IN AN INTENSE MAGNETIC FIELD. Shen, C. S. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 6: No. 10, 2736-54(15 Nov 1972).

A number of astrophysical discoveries and laboratory developments have prompted the need to consider synchrotron emission including effects of radiation reaction and quantum corrections. The Lorentz-Dirac equation is first solved to give the trajectory and radiation spectrum of a relativistic electron at strong radiation damping. The results are presented in forms which can be directly tested in experiments using megagauss magnetic fields as targets for high energy electron beams. The quantum mechanical effects which often intermingle with the classical radiation reaction effects are discussed. A quantum mechanical calculation including the effects of energy damping and quantum fluctuations is presented. The results obtained for a single electron are applied to an ensemble of electrons. The characteristics of the emission spectra are summarized in the final section for various ranges of field intensity and particle energy. (auth)

8332 NEW PHOTOPRODUCTION MODEL IN FIELD THEORY. Humpert, B. (Univ., Geneva). Nucl. Phys.; B48: No. 2, 621-43 (1972).

An explicitly gauge-invariant field-theory model for pion photoproduction is investigated. There is an infinity of contributing higher-order Feynman diagrams which are summed to the closed form of a modified pion and nucleon exchange. The altered π-exchange has the form of a relativistic absorption model and takes form-factor corrections at the nucleon vertex into account. The necessary modification of the nucleon pole to insure gauge invariance resembles a relativistic eikonal form. (auth)

8333 UNITARITY AND THE REACTION $\gamma\gamma \to \pi^+\pi^-$. Lyth, D. H. (Univ. of Lancaster, Eng.). Nucl. Phys.; B48: No. 2, 537-48(1972).

It is shown that unitarity does not in practice permit an evaluation of the coupling strength of an s-wave resonance in the reaction $\gamma\gamma \to \pi^+\pi^-$. However an approximate upper bound on the coupling is obtained, which is used to show that if such a resonance has mass 1 GeV then its effect will be small compared with the Born approximation, for c.m. energies below about 0.8 GeV. (auth)

8334 k^2-DEPENDENCE OF THE TRANSVERSE PION ELECTROPRODUCTION CROSS SECTION IN A GENERALIZED BORN TERM MODEL. Gutbrod, F. (DESY, Hamburg); Kramer, G. Nucl. Phys.; B49: 461-74(1972).

Data on π^+-electroproduction of protons are analyzed in a generalized Born term model, where the off-shell nucleon form factor $F_1(k^2)$ is allowed to differ from its on-shell value. The longitudinal-transverse interference cross section is sensitive to the ratio of the nucleon form factor to the pion form factor, and the data require this ratio to be larger than one. The resulting transverse cross section, integrated over a small t-interval, follows the slow decrease of the total inelastic cross section as a function of the photon mass squared. (auth)

8335 MESON EXCHANGE CURRENT EFFECT IN RADIATIVE np CAPTURE. Kaschluhn, F.; Lewin, K. (Humboldt Univ., Berlin). Nucl. Phys.; B49: 525-40(1972).

The pion exchange current contribution to the thermal neutron proton radiative capture cross section is calculated on the basis of potential theory by extracting a local "absorptive exchange potential" from the corresponding fourth order Feynman diagram with the deuteron nucleon vertex on the mass shell. Taking into account that the repulsive core of nucleon interaction leads to modifications not only of the wave functions (which include off-mass shell properties of the deuteron nucleon vertex) but also of this absorptive OPE potential a result is obtained which explains the main part ($\simeq^2/_3$) of the well known 10% discrepancy between experiment and impulse approximation. (auth)

8336 LIGHT CONE APPROACH TO POSITIVITY BOUNDS ON STRUCTURE FUNCTIONS FOR DEEP INELASTIC LEPTON SCATTERING IN WEINBERG'S THEORY. Scharbach, P. N. (Oxford Univ.). Nucl. Phys.; B49: 52-60(1972).

Inequalities are derived for the structure functions of deep inelastic lepton scattering via the electromagnetic, weak, and neutral currents of Weinberg's unified theory, using positivity and the assumptions of SU(2) and SU(3) symmetry. The derivations are carried out in the Fritzsch–Gell–Mann light cone language; the equivalent parton model approach is sketched. (auth)

8337 POMERON CONTRIBUTIONS TO LIGHT-CONE DOMINATED AND OTHER PROCESSES. Scott, D. M. (Cambridge Univ., Eng.). Nucl. Phys.; B49: 99-108(1972).

The presence of pomeron-generated correction terms in deep inelastic scattering is investigated in the non-perturbative parton model. There is shown to be no leading-order pomeron contribution to light-cone dominated processes, nor to semi-inclusive processes involving detected final state particles if the related inclusive process is light-cone dominated. A new class of semi-inclusive processes not of this form is described which does have diffractive corrections. (auth)

8338 QUASIELASTIC ELECTRON AND NEUTRINO INTERACTIONS AND THE EXCLUSION EFFECTS. Bernabeu, J. (CERN, Geneva). Nucl. Phys.; B49: 186-205(1972).

The correlation functions which describe the exclusion effects in quasielastic electron nucleus and neutrino nucleus reactions are studied, showing similarity and difference between them. The calculation of the total structure factors in electron scattering is done for the cases of deuterium, ^{4}He and ^{12}C. The effects of the configuration mixing mechanism tend to deviate the values given by the simple shell model towards the supermultiplet relations, then showing the intermediate coupling nature. But they are not large, and practically only affect the spin flip terms, which contribute to the neutrino and muon capture reactions—due to the axial current—but insignificantly to the electron scattering. (auth)

8339 ELECTROPRODUCTION OF ω–MESONS AND OF $\omega\Delta(1236)$ AND TEST OF THE $\gamma\omega\pi$ COUPLING. Fraas, H. (Univ., Wurzburg, Ger.). Nucl. Phys.; B49: 253-72(1972).

A simple model for forward electroproduction of ω–mesons ($\gamma_V N \rightarrow \omega N$) is investigated in a quantitative manner, especially analyzing the experimental consequences of mass dependence of diffractive production and of the $\gamma\omega\pi$ vertex. The same model is applied to the reaction $\gamma_V N \rightarrow \omega\Delta$ where pomeron exchange cannot contribute. (auth)

8340 FOUR TWO-PHOTON SEMI-INCLUSIVE REACTIONS IN THE NON-PERTURBATIVE PARTON MODEL. Evans, K. J. (Cambridge Univ., Eng.). Nucl. Phys.; B49: 345-57(1972).

In the non-perturbative covariant parton model, scaling in a Bjorken-type limit is found in four semi-inclusive reactions involving two photons. Only one of these four reactions is certain to be light-cone dominated. In this reaction each photon is virtual and for this reaction only, agreement with the results of the Fritzsch–Gell–Mann free quark light-cone algebra is verified. The limit considered is more general than that suggested by Fritzsch and Gell–Mann and entails high transverse momentum for the outgoing photon, but even so this reaction is light-cone dominated. (auth)

8341 MUON g – 2 AND OTHER CONSTRAINTS ON A MODEL OF WEAK AND ELECTROMAGNETIC INTERACTIONS WITHOUT NEUTRAL CURRENTS. Primack, J. R.; Quinn, H. R. (Harvard Univ., Cambridge, MA). Phys. Rev., D; 6: No. 11, 3171-8(1 Dec 1972).

A simple spontaneously broken gauge model of electromagnetic and weak interactions without neutral currents has recently been constructed by Georgi and Glashow. Models of this sort characteristically contain a variety of hypothetical particles: intermediate vector bosons, one or more massive scalars, heavy leptons, "charmed" hadrons. It is shown that the agreement between the conventional calculation of muon g–2 and experimental data imposes relations among the masses of the intermediate vector meson, the heavy leptons associated with the muon, and the Higgs scalar meson, in the Georgi–Glashow model. Additional constrains on models of this sort are also deduced from muonic atom data, and scattering phenomena involving the presently unobserved particles of the Georgi–Glashow model are briefly discussed. (auth)

8342 SUM RULE FOR PHOTON STRUCTURE FUNCTION νW_2^γ. Buchl, R. A.; Nigam, B. P. (Arizona State Univ., Tempe). Phys. Rev., D; 6: No. 11, 3329-30(1 Dec 1972).

It is assumed that a sum rule of the Bloom and Gilman type applies to the photon structure function $\nu W_2^\gamma(q^2,\nu)$ and the scaling limit function $\nu W_2^\gamma(\omega)$, where $\omega = -2\nu/q^2$. A dominating resonance is considered for photon-photon scattering and from the sum rule it is found that the form factor depends only on q^2. (auth)

8343 PARAMETRIC SUM RULES FOR ELECTROPRODUCTION AND TESTS OF COMPLEX SCALING AND REGGE BEHAVIOR. Healy, J. B. (Rockefeller Univ., New York). Phys. Rev., D; 6: No. 11, 3292-3300(1 Dec 1972).

Parametric dispersion relations which separately test complex scaling and Regge fits to the inelastic structure function $W_2(\nu,q^2)$ are found and evaluated. The numerical results indicate that precocious complex scaling is consistent with the present electroproduction data. The sum rule for the Regge fits is very restrictive and eliminates many of the fits proposed in the literature. The two fits which satisfy the sum rules are ones made by Pagels and by Preparata. (auth)

8344 CAN THE PION'S CHARGE RADIUS BE LARGE? Levin, D. N.; Okubo, Susumu (Univ. of Rochester, NY). Phys. Rev., D; 6: No. 11, 3149-61(1 Dec 1972).

Analyticity has been used to derive dispersive inequalities which bound the spacelike behavior of the pion's charge form factor in terms of the timelike variation of the modulus of the form factor and the p-wave $\pi\pi$ scattering phase shift. The large charge radius, suggested by the Serpukhov-UCLA measurement of πe scattering, is only compatible with timelike data which involve a large p-wave $\pi\pi$ phase shift just above threshold. (auth)

8345 SCALING BEHAVIOR OF HELICITY STRUCTURE FUNCTIONS. Cheng, T. P. (Rockefeller Univ., New York); Zee, A. Phys. Rev., D; 6: No. 11, 3182-91(1 Dec 1972).

It is shown that the general behavior $|q^2|^{|a-b|/2} W^{ab}(q^2,\omega) \sim F^{ab}(\omega)$ holds in the scaling region. W^{ab} is the absorptive forward Compton amplitude with virtual-photon helicity indices a, b. This leads to readily observable consequences in the azimuthal angular distributions of the semileptonic processes $l + p \rightarrow l' + p_1 + \ldots + p_n + X$ and $l + l' \rightarrow p_1 + \ldots + p_n + X$, where p_i are the detected hadrons, and in deep-inelastic scattering of leptons on polarized targets which includes polarized nucleon, virtual photon, and Reggeon. A study of the tensor properties of the light-cone expansion shows that, due to competition of certain higher-twist contributions, relations involving F^{ab} for $a \neq b$ are more model-dependent than relations involving only F^{aa}. Ambiguities which arise in gauge completions of light-cone expansion are illustrated by certain scaling-function sum rules. (auth)

8346 EFFECTS OF A NEUTRAL WEAK CURRENT IN THE PROCESS $e^+e^- \rightarrow \mu^+\mu^-$. Godine, John; Hankey, Alex (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 6: No. 11, 3301-6(1 Dec 1972).

The effects of a weak neutral current or a heavy neutral intermediate vector boson on the reaction $e^+e^- \rightarrow \mu^+\mu^-$ are studied. Particular attention is paid to weak-electromagnetic interference effects which may be observable even for large (>50 BeV) boson mass. The colliding beams of electrons and positrons are taken to be polarized normal to the plane of the storage ring as a result of the emission of synchrotron radiation. The helicities and angular distributions of the muons are calculated, with emphasis on those features which indicate unambiguous parity violation. The results are then specialized to Weinberg's model of leptons, where effects of order 1% are expected. (auth)

Weak

Refer also to abstracts 8427, 8448, and 8730.

8347 (IFVE-SEF-71-51) CALCULATED SPECTRA OF γ-QUANTA ($\pi^0 \rightarrow 2\gamma$), ELECTRONS ($\gamma Z \rightarrow e\bar{e}Z$), MUONS ($\pi \rightarrow \mu\nu$), AND MUONIC PAIRS WITH A LARGE INVARIANT MASS ($\gamma p \rightarrow \mu\bar{\mu}p$) AT THE IHEP ACCELERATOR. Makeev, V. V.; Folomeshkin, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The γ-quantum and muon spectra from the decay of $\pi \rightarrow 2\gamma$ and $\pi \rightarrow \mu\nu$ were calculated for the 70-GeV accelerator. Using these γ-quantum spectra the electron and positron conversion spectra and the spectrum for the invariant masses of muonic pairs in the reaction $\gamma p \rightarrow \mu\mu p$ are calculated. (auth)

8348 HEAVY LEPTONS IN COSMIC RAYS. Pakvasa, S.; Simmons, W. A.; Tennakone, K. (Univ. of Hawaii, Honolulu). pp 1189-93 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 3).

Heavy lepton models by Bjorken and Simmons and Pakvasa and Tennakone are summarized and their relation to cosmic ray anomalies is discussed. (Australia)

8349 HIGHER-ORDER CONTRIBUTIONS TO μ DECAY IN A SPONTANEOUSLY BROKEN GAUGE MODEL. Applequist, T. W.; Primack, J. R.; Quinn, H. R. (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 6: No. 10, 2998-3011(15 Nov 1972).

The one-loop contributions to μ decay are calculated in Weinberg's model of the weak and electromagnetic interactions of leptons. The higher-order weak contributions are shown to be finite in this model, despite the high order of divergence of individual Feynman graphs. Thus this calculation is practical evidence in favor of the renormalizability of spontaneously broken gauge theories. The electromagnetic corrections to μ decay are finite after renormalization in the Weinberg model. The renormalized higher-order weak corrections do not affect the shape of the final electron spectrum. The effect on the μ decay rate is of the same order of magnitude as the electromagnetic correction, $\sim\frac{1}{2}\%$. Since this is effectively just a small "renormalization" of the weak coupling constant, it appears to be impossible to detect this effect experimentally unless other weak processes can be calculated and measured with comparable precision. The calculation is done by evaluating Feynman graphs dispersively. This calculational technique may be of interest in further work with spontaneously broken gauge theories. (auth)

8350 DIVERGENCES OF THE HIGHER-ORDER CORRECTIONS TO μ DECAY IN WEINBERG'S GAUGE THEORY. Rajasekaran, G. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 6: No. 10, 3032-5(15 Nov 1972).

The leading (quadratic) divergences in the second-order weak and electromagnetic corrections to μ decay are calculated in Weinberg's gauge theory, and it is shown that, after renormalization, these divergences cancel. (auth)

8351 CAN THE ADLER INELASTIC LEPTON–HADRON SUM RULE EVER BE SATISFIED? Sakurai, J. J. (Univ. of California, Los Angeles); Thacker, H. B.; Tuan, S. F. Nucl. Phys.; B48: No. 2, 353-64(1972).

An extensive analysis of the Adler sum rule for neutrino processes is carried out. It appears that the sum rule is not saturated unless (i) remarkably slow convergence of the Adler integral or (ii) bizarre behavior of $F_2^{\nu n}$ and $F_2^{\nu p}$ for $1 \leq \omega \lesssim 5$ is allowed. (auth)

8352 DEEP INELASTIC ELECTRO- OR MUOPRODUCTION OF W-BOSONS: A TEST OF THE BILOCAL ALGEBRA. Jarlskog, C.; Roy, Probir (CERN, Geneva). Nucl. Phys.; B48: No. 2, 415-28(1972).

The study of the reactions $lN \rightarrow lW^{\pm}$ + anything (l is a charged lepton, the W has a mass greater than 3 GeV and no strong interactions) at large leptonic momentum transfers is proposed as a test of the algebra of bilocal currents formulated recently by Fritzsch and Gell-Mann. The applicability of the algebra to these processes is first established by showing that in the Fourier transform of the squared matrix element all currents act on a lightlike ray. Using a parton analogy, explicit expressions are then given for the differential cross sections in terms of the deep inelastic neutrino structure functions. The feasibility of this experiment at NAL is discussed briefly. (auth)

8353 REMARK ON $K_L \rightarrow 2\mu$ DECAY AND POSSIBLE EXISTENCE OF NEW PARTICLES. Dolgov, A. D.; Grigoryan, G. V.; Nikolaev, N. N.; Okun, L. B.; Zakharov, V. I. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys.; B48: No. 2, 392-6(1972).

The possibility of production of new particles in yet unobserved decay channels of the K_L meson is discussed in connection with the $K_L \rightarrow 2\mu$ puzzle. Experimental possibilities of searching for these particles are considered. (auth)

8354 MUON–PROTON SCATTERING AND THE EFFECT OF NEUTRAL CURRENTS IN THE SCALING REGION. Love, A. (Rutherford High Energy Lab., Chilton, Eng.); Ross, G. G.; Nanopoulos, D. V. Nucl. Phys.; B49: 513-24(1972).

The problem of testing weak-interaction models with the next generation of accelerators is discussed, and it is concluded that muon–proton scattering must be considered. The cross sections for both polarized and unpolarized targets are obtained in the scaling region. The feasibility of detecting neutral weak currents is examined and optimum kinematical conditions to do this are found. Finally ways to isolate the neutral weak current are suggested. (auth)

8355 ORDER α CORRECTIONS TO MUON CAPTURE IN HYDROGEN. Goldman, M. R. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys.; B49: 621-32(1972).

The order α corrections to muon capture arising from two sources: small components of the spinors of the muon and proton, and quantum electrodynamic effects are considered. The first is shown to give no effect, while the second gives a correction factor of $+ (\alpha/\pi)(2.95)$ to the decay rate. (auth)

8356 DOUBLE-POLE MODEL FOR THE K_{l3} FORM FACTORS. Olshansky, R. (Laboratoire de Physique Theorique et Hautes Energies, Paris); Yem, P. X. Phys. Rev., D; 6: No. 11, 3145-9(1 Dec 1972).

The model of Gerstein, Gottfried, and Huang for the pion electromagnetic form factor is extended to K_{l3} decays. One characteristic of the model is the appearance of double poles which enhance the slopes of form factors. One gets $\lambda_+ \simeq 0.05$ and $\xi(0) \simeq -0.32$. (auth)

8357 UNIFIED EXPLANATION OF THE $K_L^0 \rightarrow 2\mu$ PUZZLE, CP NONCONSERVATION, AND EXCESS MUON ANOMALY. Pakvasa, S.; Tuan, S. F. (Univ. of Hawaii, Honolulu). Phys. Rev., D; 6: No. 11, 3342-6(1 Dec 1972).

A common explanation of (a) the $K_L^0 \rightarrow \mu^+\mu^-$ puzzle, (b) CP nonconservation, and (c) the cosmic-ray muon anomaly of Utah is proposed. The model involves a pair of neutral bosons with pairwise strong interactions with known hadrons. Experimental implications are discussed. (auth)

8358 VALUE OF THE ξ PARAMETER IN K_{l3} DECAY FROM THE PION-GAUGE CONDITION. Barut, A. O.; Aydin, Z. Z. (Univ. of Colorado, Boulder). Phys. Rev., D; 6: No. 11, 3340-2 (1 Dec 1972).

It is shown with the help of the pion-gauge condition that the divergence of the most general boson current in K_{l3} decay vanishes in the limit of zero four-momentum of the pion. This in turn implies $\xi = -1$ at the (unphysical) point $t = m_K^2$. Inasmuch as ξ does not seem, experimentally, to vary much with t, the result is significant in the physical region and agrees with experiment. (auth)

8359 INTERMEDIATE BOSON. III. VIRTUAL-BOSON EFFECTS IN NEUTRINO TRIDENT PRODUCTION. Brown, R. W. (Case Western Reserve Univ., Cleveland); Hobbs, R. H.; Smith, J.; Stanko, N. Phys. Rev., D; 6: No. 11, 3273-92(1 Dec 1972).

The production of lepton tridents by neutrinos in a Coulomb field is a sensitive test of the diagonal terms in weak-interaction theory. If a charged vector boson exists then it can participate in such reactions as a virtual particle or a real one if the incident beam energy is sufficiently high. A neutral vector boson with no magnetic moment cannot interact with the electromagnetic field; so it participates only as a virtual particle. Two different effects due to these bosons are examined. First that they have different effective couplings which modify the V–A interaction to a more general combination of vector and axial-vector currents. At this level changes in the over-all coupling strength are more important than retaining effects due to the virtual-propagators. The recent model of Weinberg belongs to this classification. Second, the paopagator effect of a charged vector boson mediating the usual V–A theory is investigated. (auth)

8360 SEMI-INCLUSIVE REACTIONS INDUCED BY LEPTONS. Gourdin, M. (Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France). Nucl. Phys.; B49: 501-12(1972).

General properties of semi-inclusive reactions induced by polarized leptons on an unpolarized or spin $\frac{1}{2}$ polarized target are studied from the point of view of kinematics and invariance

principles. Structure functions are defined and positivity conditions given. (auth)

8361 STRONG ISOTOPIC-SPIN BREAKING AND NONLEPTONIC K DECAY. Holstein, B. R. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 6: No. 11, 3266-9(1 Dec 1972).

$\Delta I = 3/2$ effects in nonleptonic kaon decay predicted by strong isotopic-spin breaking with an exact $\Delta I = 1/2$ weak Hamiltonian are compared with those which follow from an intrinsic $\Delta I = 3/2$ Hamiltonian. (auth)

8362 NONLEPTONIC HYPERON DECAYS IN THE QUARK MODEL. Sastry, C. V. (Regional Engineering Coll., Orissa, India). Phys. Rev., D; 6: No. 11, 3270-2(1 Dec 1972).

The quark model was used to obtain s- and p-wave amplitudes for nonleptonic hyperon decays. While all the s-wave amplitudes could be related, only one sum rule for the p-wave amplitudes was obtained. (auth)

Strong (General)

8363 (JINR-P2-6654) HARD AND SOFT QUANTA EXCHANGE IN HIGH-ENERGY PARTICLE SCATTERING. Barbashov, B. M.; Nesterenko, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

In order to take into account the contribution from the exchange of both finite number of hard quanta and infinite number of soft virtual particles to the scattering amplitude, the closed form of the scattering amplitude in terms of functional integrals is used. The contribution of the finite number of the exchange quanta (hard mesons) to the amplitude is singled out by means of an identity. By a subsequent approximate calculation of the functional integrals (straight-line path approximation) the contribution of the selected quanta is exactly conserved. Neglecting the correlation between the hard and soft exchange the elastic form factors of the scattering particles may be picked out. In so doing the contribution of the hard quanta is described by the exact perturbation series. It is reasonable to suppose that the amplitude in the given form describes the high energy scattering at wide angles. This is in agreement with the Wu-Yang conjecture on the role of the elastic form factors in high energy scattering. (auth)

8364 TORINO SEARCH FOR QUARKS. IV. RE-ASSESSED UPPER LIMITS OF QUARK FLUXES. Bosia, G. (CNR, Turin); Briatore, L.; Sitte, K. pp 1150-5 of 12th International Conference on Cosmic Rays. Vol. 3. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 3).

In an attempt to estimate possible errors in earlier flux experiments, the efficiency of quark detection by a telescope experiment was studied under the assumptions of three production models. These were chosen arbitrarily to include extreme alternatives of energy transfer, with the goal to establish safe limits rather than to describe a situation believed to be correct in all details. (orig/MRM)

8365 PION DISTRIBUTIONS IN HADRONS COLLISIONS. REMARKS AND CALCULATIONS. Jasselette, P.; Vandermeulen, J. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 40: No. 5-8, 250-61(1971).

Recent experimental results and proposed interpretations of multiple emissions of pions in high energy hadron collisions are reviewed. The results are reexamined in the light of a model proposed by Caneshi and Schwimmer to account for the multiperipheral character of the collision. It is shown that neither the assumption of uncorrelated pion production nor a simplified account of resonances can reproduce details of the experimental distributions beyond the prong number distribution. (auth)

8366 TRIPLE REGGE LIMIT IN THE ABSORPTIVE MULTIPERIPHERAL MODEL. Caneschi, L. (CERN, Geneva); Schwimmer, A. Nucl. Phys.; B48: No. 2, 519-24(1972).

The $x \to 1$ limit of the inclusive one-particle distribution is studied in the absorptive multiperipheral model: a leading behavior of the type $(1-x)^{-1} \ln^{-3}(1-x)$ is found, which gives an integrable contribution to the energy conservation sum rule. (auth)

8367 TWO CLASSES OF DUAL MODELS WITH SPONTANEOUS SYMMETRY BREAKING. Schwarz, J. H. (Univ. of California, Berkeley). Nucl. Phys.; B48: No. 2, 525-36(1972).

Two new classes of dual models are presented. One required technique is the introduction of spontaneous symmetry breaking by means of assigning a non-vanishing vacuum expectation value to the dual-model operator L_0. Another is the use of "non-canonical" spaces—spaces that cannot be generated by use of ordinary a- and b-type oscillators. The first class of models is characterized by two non-negative integers (M,N) and has a ground-state mass μ_0 given by $\alpha'\mu_0^2 = 3/2\ M + 2N - 1$. These models possess L-type (Virasoro) gauge operators. The (0,0) model is the usual Veneziano model with intercept one, while the (0,1) model is probably equivalent to the intercept-minus-one model recently discovered by Gervais and Neveu. The second class of models is characterized by a single non-negative integer M and has a ground-state mass μ_0 given by $\alpha'\mu_0^2 = 3/2\ M - 1/2$. These models possess G-type gauges and each of them can be extended to include fermions. The M = 0 case corresponds to the dual pion model. Even though the new models have large gauge algebras, all of them contain ghost states. A loose end in the presentation is the absence of a general proof of cyclic symmetry for the n-point amplitudes. (auth)

8368 INCLUSIVE DISTRIBUTIONS NEAR THE CENTRAL REGION IN A DYNAMICAL POMERON COUPLING MODEL. Yazaki, S. (Tokyo Univ.). Nucl. Phys.; B49: 71-6(1972).

The observed suppression of K-meson inclusive production is explained on the basis of the pomeron coupling scheme proposed by Carlitz, Green, and Zee. Relations between K and π inclusive distributions near the central region are also derived. (auth)

8369 DYNAMICAL MODEL OF HADRONS WITH FERMION QUARKS. Drell, S. D.; Johnson, K. (Stanford Univ., CA). Phys. Rev., D; 6: No. 11, 3248-55(1 Dec 1972).

A dynamical quark model of hadrons is constructed in terms of the usual triplet of fractionally charged spin-$1/2$ quarks (q). They have a light mass ($\approx$300 MeV) and obey Fermi-Dirac statistics. In approximate nonrelativistic terms, the quark interactions are assumed to be described by a long-range effective single-particle Hartree potential with infinitely rising walls and by a strong short-range Yukawa-type one between quark pairs. These combine to prevent single-quark emission from a hadron and to give the observed early scaling and the asymptotic electromagnetic form factors $\sim 1/t^2$. The energy-momentum propagating in the field between the interacting quarks is idealized as a virtual particle (the "core" of the baryon) so that the center of mass of the three quarks in the baryon and of the $q\bar{q}$ in the meson is not constrained. Implications of this model are discussed—in particular, the baryon wave functions and energy spectrum, the form-factor behavior, the Adler anomaly for $\pi^0 \to 2\gamma$ decay, and the hadronic interactions. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 8441, 8463, and 8471.

8370 SINGLET BOSON TRAJECTORY. Peaslee, D. C. (Purdue Univ., Lafayette, IN). Phys. Rev. Lett.; 29: No. 23, 1573-5(4 Dec 1972).

A quark-model state $^1F_3$ is assigned in the presumably Q-like $K\pi\pi$ peak around 2.16 GeV. The resulting Regge trajectory is linear and exchange degenerate and has an anomalous slope, $\alpha' \simeq 0.67\ \mathrm{GeV}^{-2}$. The fundamental significance of this nonparallelism is pointed out, and measurements are proposed to confirm the assignment. (auth)

8371 PION RADIUS AND ISOVECTOR NUCLEON RADII IN THE LIMIT OF SMALL PION MASS. Beg. M. A. B.; Zepeda, A. (Rockefeller Univ., New York). Phys. Rev., D; 6: No. 10, 2912-18(15 Nov 1972).

The pion radius and the isovector nucleon radii are studied in the limit in which the pion mass approaches zero. The leading terms in this limit are calculated. (auth)

8372 REFORMULATION OF THE CROSSING-UNITARITY EQUATION IN TERMS OF PARTIAL WAVES. Atkinson, D. (Inst. of Theoretical Physics, Groningen, Netherlands); Johnson, P. W.; Warnock, R. L. Phys. Rev., D; 6: No. 10, 2966-76 (15 Nov 1972).

The Mandelstam construction of crossing-symmetric, unitarity amplitudes for pion-pion scattering is reformulated in terms of partial waves. The amplitude is obtained by solving a set of nonlinear equations for the physical partial-wave amplitudes. A conformal mapping of the $\cos\theta$ plane, introduced by Ciulli, Cutkosky, and Deo, is used to implement crossing symmetry. It is shown that the equations have a solution, which may be constructed by means of a convergent iteration. (auth)

8373 RIGOROUS PARAMETRIC DISPERSION REPRESENTATION WITH THREE-CHANNEL SYMMETRY. Auberson, G.; Khuri, N. N. (Rockefeller Univ., New York). Phys. Rev., D; 6: No. 10, 2953-66(15 Nov 1972).

Starting with an analyticity domain in the two Mandelstam vari-

ables which is contained in the domain obtained by Martin, a parametric dispersion representation for scattering amplitudes in the equal-mass case is derived. For pion-pion scattering this representation is a rigorous consequence of the axioms of local field theory; it displays in a symmetric and explicit way the contributions of all three channels, and it has only "physical" absorptive parts. This representation is useful for deriving sum rules involving only absorptive parts and relating all three channels. Some of these sum rules are given, the most important of which form a set of independent physical relations that lead to necessary and sufficient conditions ensuring full crossing symmetry. (auth)

8374 NOTE ON THE SELF-CONSISTENT CALCULATION OF π-π RESONANCE PARAMETERS. Sharma, M. L.; Bondyopadhyay, D. (Univ. of Delhi). Phys. Rev., D; 6: No. 10, 2919-23 (15 Nov 1972).

A self-consistent calculation of π-π resonance parameters is attempted in a model suggested by Balázs. Two variations of the model are considered. The input in this calculation is the experimental masses and widths of the ρ, f_0, and g resonances and the inelasticities, known as well as arbitrary, in the corresponding partial waves. Bootstrap possibilities in different isospin and partial-wave states are discussed. (auth)

8375 CONSEQUENCES OF UNITARITY IN A VENEZIANO AMPLITUDE. Kreps, R. E.; Zeber, S. F. (Univ. of Toronto). Phys. Rev., D; 6: No. 10, 2891-7(15 Nov 1972).

A general method is presented for unitarization via a complex trajectory function, and arguments are presented for its validity in the π-π problem. The method is applied to a Veneziano amplitude with two satellites. Solutions are found to exist from threshold to slightly above the ρ mass and appear to require a markedly nonlinear Regge trajectory. Reasons for the failure of the solutions to exist above the ρ mass are discussed. (auth)

8376 CALCULATION OF VECTOR MESONS IN FUNCTIONAL NONLINEAR SPINOR THEORY. Bauhoff, W.; Scheerer, K. (Univ., Tuebingen, Ger.). Z; Naturforsch.; 27a: No. 11, 1539-53(Nov 1972).

Nonlinear spinor theory is formulated in functional space. An eigenvalue equation for mesons is derived. The group theoretical reduction of this equation is performed, especially the angular momentum decomposition. For vector mesons it is solved in first Fredholm approximation. A solution corresponding to a physical particle is found contrary to earlier calculations. The calculated mass has the correct order of magnitude. (auth)

8377 POSITIVITY AND CROSSING SYMMETRY: AN APPLICATION OF MOMENT INEQUALITIES TO UNITARIZED $\pi-\pi$ VENEZIANO MODELS. Griss, M. L. (California Inst. of Tech., Pasadena). Nucl. Phys.; B48: No. 2, 446-60(1972).

The advantages of the Balachandran and Nuyts double partial-wave expansion for the testing of both crossing symmetry and positivity in low-energy $\pi-\pi$ models are discussed. Particular emphasis is laid on the need for numerical accuracy in order to obtain significant results, and a number of simple unitarized Veneziano models are examined as an illustration of the techniques. (auth)

8378 PARTICLE PRODUCTION IN ANNIHILATION PROCESSES. I. BARYON NUMBER. Amann, R. F. (Syracuse Univ., NY). Nucl. Phys.; B49: 159-72(1972).

The importance of annihilation processes as clean tests of models for particle production is stressed. Multiperipheral concepts are used to derive successful sum rules for annihilation cross sections and their accompanying inclusive distributions. These sum rules allow Feynman scaling and the Mueller Regge analysis to be carried over into the annihilation channel. They are further utilized to define a no parameter multiperipheral model for baryon number annihilation. This model is shown to provide a remarkably successful description of the gross features of the annihilation process from annihilations at rest up to the highest explored energies. (auth)

8379 CONSISTENCY BETWEEN THE LOW-ENERGY PION–PION INTERACTION AND PION–NUCLEON SCATTERING. Nielsen, H. (Univ. of Aarhus, Denmark); Oades, G. C. Nucl. Phys.; B49: 586-609(1972).

The $\pi\pi-N\bar{N}$ helicity amplitudes $f^{\frac{1}{2}}_{\frac{1}{2}}$ and $f^{\frac{1}{2}}_{-\frac{1}{2}}$ are calculated assuming certain $\pi\pi$ phases δ^0_0 and δ^1_1 and taking careful account of errors. These values are then compared with πN data via partial wave and backward dispersion relations. Excellent agreement is obtained with a conventional ρ-form for δ^1_1 but in the case of δ^0_0 one requires the low energy behavior of the Morgan–Shaw favored phase BD1 to be somewhat reduced to give a scattering length in the range $-0.15 \lessapprox a^0_0 \lessapprox 0.10$. (auth)

8380 PION–PION SCATTERING BASED ON CURRENT ALGEBRA, ANALYTICITY, AND UNITARITY. Prasad, S. C.; Brehm, J. J. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 6: No. 11, 3216-32(1 Dec 1972).

Using SU(2) × SU(2) current algebra and pion-pole dominance, an exact crossing-symmetric expression for the $\pi\pi$ scattering amplitude is derived from the Ward identities. Approximations are made which are suitable at low energy for those three- and four-point functions of the problem which cannot be determined from the constraints of current algebra. These functions are parametrized in terms of propagators and polynomials exhibiting the correct analyticity properties. Form factors, analytic in the cut plane, are expressed in effective-range form, and the s- and p-wave amplitudes are constructed in terms of them. The existence of resonance in the $\pi\pi$ system is not assumed, and soft-pion estimates are not used. Instead all the parameters are free to be varied. All the free parameters of the problem are determined self-consistently by imposing the constraints that follow from elastic unitarity. The scheme predicts all the features of low-energy $\pi\pi$ scattering, the only input parameters being m_π and F_π, the pion mass and decay constant. Among the principal results are the s- and p-wave scattering lengths, the corresponding phase shifts, and the determination of an important parameter which measures the isospin T = 2 component of the σ commutator, σ^{ab}. The details of the method predispose scattering lengths to be small. It is found unitarity prefers the T = 2 component of σ^{ab} to be small relative to the T = 0 component. As a consequence, the scattering lengths are in excellent agreement with those obtained by Weinberg. The T = J = 1 phase shift exhibits a ρ resonance around 915 MeV with a width of 210 MeV. The T = 2, J = 0 phase shift is small and in agreement with experimental results. The T = J = 0 phase shift displays acceptable behavior at low energy; physical arguments are offered to say that its higher-energy behavior is less reliable than that of the p wave at the same energies. The results are discussed and the predictive power of the method presented is analyzed. Finally, some improvements on the calculations are suggested, including possible applications to related problems. (auth)

8381 SOFT-PION EMISSION IN PROTON–ANTIPROTON ANNIHILATION. Uritam, R. A. (Boston Coll., Chestnut Hill, MA). Phys. Rev., D; 6: No. 11, 3233-41(1 Dec 1972).

The amplitude for the annihilation process $\bar{p}p \to K^+K^-\pi^+\pi^-$, and the differential rate for $\bar{p}p \to K^+K^-\pi^+\pi^-$, normalized to the $\bar{p}p \to K^+K^-$ rate, in the soft-pion limit are calculated for annihilation in flight at vanishing momentum. The computation uses the formalism of current algebra and PCAC (partially conserved axial-vector current); of particular interest is the use of Low's soft-photon theorem to evaluate the isovector photon term. The final result is expressed as the $\bar{p}p \to K^+K^-\pi^+\pi^-$ rate, differential in all five independent kinematic variables, chosen for their symmetry and their utility in comparing with experimentally determined spectra. The integral of this expression yields the branching ratio $\bar{p}p \to K^+K^-\pi^+\pi^-/\bar{p}p \to K^+K^- = 2.25$, in reasonable agreement with experiment. (auth)

8382 ABSORPTION PICTURE AS A CONSEQUENCE OF MULTI-REGGE ITERATION OF LOW-ENERGY PERIPHERAL RESONANCES. Desai, B. R. (Univ. of California, Riverside). Phys. Rev., D; 6: No. 11, 3241-7(1 Dec 1972).

Using the empirical fact that the dominant low-energy resonances are peripheral (i.e., they satisfy the relation $j_s + \frac{1}{2} = kR \approx \frac{1}{2}R\sqrt{s}$), the imaginary part, $A_0(s,t)$, of the low-energy amplitude is written in the factorized form $F(s)J_0(R\sqrt{-t})$. The resonance contribution to F(s) near the resonance position is $\approx(2j_s + 1)$, which is $\approx s^{\frac{1}{2}}$; and thus the well-known value for the vector-tensor trajectory intercept of $\approx\frac{1}{2}$ follows simply from peripherality. From finite-energy sum rules the residue of the trajectory is $\approx J_0(R\sqrt{-t})$. The quantity $A_0(s,t)$, which in the t channel corresponds to a fixed pole at $j_t = \frac{1}{2}$, through the multi-Regge iteration gives rise to a moving pole; and the imaginary part of the total $\pi\pi$ amplitude A(s,t) with $I_t = 1$ satisfies the dual absorption result, $s^\alpha J_0(R\sqrt{-t})$. A crude estimate gives $\alpha(0) \approx \frac{1}{2} + (\Gamma_\rho/m_\rho)$ (=0.6) and $\alpha'(0) \approx \frac{1}{4}(\Gamma_\rho/m_\rho)R^2$ (= 1.0 BeV^{-2} for R = 1 F). Thus, for nondiffractive processes, the multi-Regge for multiperipheral) model is consistent with the absorption picture and as a consequence an approximate bootstrap solution is obtained. The physical interpretation in terms of j-plane cuts is discussed. (auth)

8383 ANALYSIS OF THE ANOMALY IN THE $\pi^+\pi^-$ SYSTEM NEAR THE $K\bar{K}$ THRESHOLD. Williams, P. K. (Florida State Univ., Tallahassee). Phys. Rev., D; 6: No. 11, 3178-81(1 Dec 1972).

An absorption-modified pion-exchange model with coupled-channel unitarity and analyticity for the $\pi^+\pi^-$ system near the $K\bar{K}$ threshold is introduced. Data-analysis techniques for the reactions $\pi + N \to$ meson + meson + baryon are discussed. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 8231, 8282, and 8541.

8384 (INS-J-135) K^+p ELASTIC SCATTERING BETWEEN 1.3 AND 2.5 GeV/c. Kondo, Kunitaka (Tokyo Univ. (Japan). Inst. for Nuclear Study). 12 Sep 1972. 26p. Dep. NTIS (U. S. Sales Only).

The experimental data of the K^+p elastic scattering between 1.3 and 2.5 GeV/c are compared with a theoretical model which consists of the Veneziano amplitude and the single Regge-pole Pomeranchon. The minimum χ^2 equal to 213 for 107 typical data points with 5 free parameters for the Pomeranchon amplitude is obtained. The slope of the Pomeranchuk trajectory is 0.45 $(GeV/c)^{-2}$ for the best fit. To improve the fit an energy independent phase shift analysis is made by changing the s-, p- and d- wave components near the projected values of the model. The $P_{\frac{1}{2}}$ wave shows a counter clockwise motion in the Argand diagram. (auth)

8385 INCONSISTENCY IN THE VALUE OF THE D/F RATIO FOR THE AXIAL-VECTOR CURRENT. Whippman, M. L. (Univ. of Helsinki). Phys. Rev., D; 6: No. 10, 3037(15 Nov 1972).

An inconsistency pointed out by Kaushal and Khanna is shown not to occur. (auth)

8386 TESTS OF THE OPTICAL THEOREM. Eberhard, P. H. (CERN, Geneva). Nucl. Phys.; B48: No. 2, 333-42(1972).

Present experimental data shows that the optical theorem is valid for πp scattering above 1 GeV/c up to 90% or 95%. The residual discrepancy of 5 or 10% can be explained if some experimental error has not been included in the published values, if the shape assumed for elastic scattering in the analysis is incorrect for values of momentum transfer square near 0.01 $(GeV/c)^2$ or less, or if the optical theorem is violated. (auth)

8387 ABSORPTIVE EFFECTS IN THE REACTIONS $K^-p \to K^-\pi^+n$ AND $K^+n \to K^+\pi^-p$. Kimel, J. D.; Reya, E. (Florida State Univ., Tallahassee). Nucl. Phys.; B48: No. 2, 573-88(1972).

A general single pion exchange absorption model, particularly suitable for including absorptive effects in analyses of $K\pi$ scattering, is studied for the reactions $K^-p \to K^-\pi^+n$ and $K^+n \to K^+\pi^-p$. If strong cuts are operative, excellent fits to the production and decay data are obtained for both these reactions in the $K\pi$ mass range around the $K^{*0}(890)$. In addition, high energy predictions are given and the systematic errors predicted to occur in evasive Chew–Low extrapolations discussed. (auth)

8388 DETERMINATION OF THE πN COUPLING CONSTANT f^2 AND THE PION–NUCLEON s-WAVE SCATTERING LENGTHS. Sznajder Hald, N. (NORDITA, Copenhagen). Nucl. Phys.; B48: No. 2, 549-56(1972).

The coupling constant f^2 and s-wave scattering lengths a_1, a_3 are determined from the once subtracted forward dispersion relations for the $\pi^\pm p$ scattering amplitudes $F_\pm$ using total and (Coulomb corrected) differential cross sections. The obtained values are: $f^2 = 0.0816 \pm 0.0029$, $a_1 = 0.187 \pm 0.009$, $a_3 = -0.105 \pm 0.006$. (auth)

8389 PION–NUCLEON PARTIAL WAVE AMPLITUDES IN THE LOW-ENERGY REGION AND BELOW THRESHOLD. Nielsen, H. (Univ. of Aarhus, Denmark); Oades, G. C. Nucl. Phys.; B49: 573-85(1972).

Four tables of πN phase shifts below 270 MeV derived via finite contour fixed-t dispersion relations are presented, each table corresponding to a particular set of input assumptions. Also values of the partial wave amplitudes in the unphysical region $(M-\mu)^2 \leq s \leq (M+\mu)^2$ are derived and values for the s-, p-, and d-wave scattering lengths are given. (auth)

8390 FORWARD DISPERSION RELATION CONSTRAINTS ON THE PION-NUCLEON p-WAVE AND D-WAVE SCATTERING LENGTHS. Samaranayake, V. K. (Univ. of Ceylon, Colombo); Woolcock, W. S. Nucl. Phys.; B49: 128-40(1972).

Data on the pion-nucleon s-wave scattering amplitudes, obtained from low energy experiments, were analyzed using parametric forms suggested by forward dispersion relations. Values of $(a_1 - a_3)$ and $(a_1 + 2a_3)$, obtained by extrapolation of values of $D_\pm(\omega)$ to $\omega = \mu$ using forward dispersion relations, were also used as input data. The s-wave curvatures obtained from this analysis are used to give two constraints on the p-wave scattering lengths. Three further constraints on the p-wave scattering lengths and three similar constraints on the d-wave scattering lengths were also evaluated, using the value $f^2 = 0.0763$ obtained previously. This enables the p-wave scattering lengths to be determined; the results are: $a_{11} = (-84.5 \pm 10.2) \times 10^{-3}$, $a_{13} = (-26.6 \pm 6.3) \times 10^{-3}$, $a_{31} = (-42.9 \pm 7.1) \times 10^{-3}$, and $a_{33} = (204.1 \pm 4.5) \times 10^{-3}$. (auth)

8391 EXCHANGE STRUCTURE OF N, DELTA BACKWARD PEAKS. Barger, V.; Halzen, F.; Olsson, M. G. (Univ. of Wisconsin, Madison). Nucl. Phys.; B49: 206-20(1972).

The $I_u = \frac{1}{2}$ and $I_u = \frac{3}{2}$ cross sections and interference term in πN backward scattering are separated from data for $p_{lab} > 3$ GeV/c. The separated cross sections and recent 6 GeV/c polarization data imply restrictions on the structure of N and Δ exchange amplitudes near the dip location in π^+p backward scattering. The possibility of an amplitude analysis is discussed and the importance of polarization experiments in $\bar{K}N \to \Lambda\pi$ stressed. The determinations of $\pi N \to N\pi$ $I_u = \frac{1}{2}$ and $\frac{3}{2}$ contributions permit unambiguous studies of SU(3) for the exchanges in $\pi N \to N\pi$ and $\bar{K}N \to Y\pi$ reactions. Finally it is shown how isospin regularities observed in 180° scattering at low energies are implied by duality of N_α, Δ_δ Regge pole exchanges. (auth)

8392 FERMION VERTICES AND DIFFRACTIVE DISSOCIATION. Gault, F. D.; Walters, P. J. (Univ. of Durham, Eng.). Nucl. Phys.; B49: 273-84(1972).

The results of a previous paper which explored and tabulated the relationship between covariant Regge vertices and s-channel helicity vertices are extended and helicity vertices for spin $\frac{1}{2} \to \frac{1}{2}$. $\frac{3}{2}$, $\frac{5}{2}$, $\frac{7}{2}$ transitions are tabulated. The formalism is applied to pomeron exchange in $\pi N \to \pi N^*$ ($\frac{3}{2}^-$, 1525) πN^* ($\frac{5}{2}^+$, 1688) diffractive dissociation and the effects of helicity conservation in the s- and t-channel along with various t-channel nonsense mechanisms are studied. A hypothesis is made that the pomeron is characterized by its γ_β coupling to the fermion vertex rather than its ability to conserve helicity and this is shown to be compatible with the data fitted. (auth)

8393 FIXED POLES IN THE t-CHANNEL HELICITY-FLIP AMPLITUDE IN CHARGE- AND HYPERCHARGE-EXCHANGE REACTIONS. Gabarro, J.; Pajares, C. (Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France). Nucl. Phys.; B49: 285-301(1972).

An attempt is made to find evidence for fixed poles in two-body meson-baryon scattering. The contributions of wrong-signature fixed poles occur in wrong-signature sum rules. The first wrong-signature sum rule is evaluated for the t-channel helicity flip amplitude in πN, $\bar{K}N$ charge-exchange and in hypercharge-exchange scatterings. According to recent theoretical analysis the $J = 0$ $\bar{K}N$ charge-exchange wrong-signature fixed pole is generated, via t-channel unitarity, from the πN one. Its existence implies a $J = 0$ $\bar{K}N$ charge-exchange right-signature fixed pole. Evidence for the existence of a $J = 0$ wrong-signature fixed pole is found in all of them. It is also found that the non-peripheral resonances are mainly responsible for all these fixed poles. (auth)

8394 STRUCTURE OF ELASTIC SCATTERING: ARE TENSOR EXCHANGES PERIPHERAL? Barger, V.; Geer, K.; Halzen, F. (Univ. of Wisconsin, Madison). Nucl. Phys.; B49: 302-14 (1972).

The energy dependences of $\pi^\pm p$, $K^\pm p$, pp and $\bar{p}p$ elastic scattering data in the 3 to 30 GeV range are represented by effective trajectories. A simple law dependence is possible for all reactions but pp, which exhibits a break in energy dependence at 8 GeV. A pure pomeron interpretation of K^+p and pp requires a pomeron trajectory slope $\alpha_P' \approx 0.7$, in disagreement with recent determinations from $\gamma p \to \phi p$ and pp ISR experiments. For pomeron trajectory slopes in the range $0 < \alpha_P' < 1$, the imaginary part of the f non-flip exchange amplitude is calculated from sums $[d\sigma/dt(\bar{A}B) + d\sigma/dt(AB)]$. The structure of the f residue is dependent on the value of α_P'. For $\alpha_P' < 0.4$ the f amplitude is definitely non-peripheral whereas for $\alpha_P' \approx \alpha_f' \approx 1$ it is peripheral. On the basis of the overall evidence on other tensor exchanges and on the pomeron trajectory slope it is concluded that the dual absorption model fails to describe the nonperipheral structure of tensor exchange amplitudes. (auth)

8395 AMPLITUDE ANALYSIS OF πN SCATTERING NEAR FORWARD DIRECTIONS. Pietarinen, Esko (Nordita, Copenhagen). Nucl. Phys.; B49: 315-32(1972).

An analysis of πN scattering amplitudes is performed for -0.1 GeV$^2 \geq t \geq -0.5$ GeV^2. The resulting amplitudes have exact fixed-t analyticity and s-u crossing properties. They are consistent with the low-energy πN phase shifts and differential cross section, polarization and R-parameter measurements at all energies for $t \geq -0.5$ GeV^2. Uniqueness of the amplitude determination is considered. (auth) 3

8396 ANALYSIS OF BREAKUP SCATTERING IN A DEUTERIUM TARGET. APPLICATION TO ANTIPROTON–DEUTERON BREAKUP SCATTERING. MacDowell, C. E.; Opat, G. I. (Univ. of Melbourne). Nucl. Phys.; B49: 333-44(1972).

The problems of extracting low momentum-transfer cross sections for the "elastic" scattering of a projectile particle by the "neutron" in a deuterium target are discussed for the case

in which the deuteron breaks up. The difficulties in the analysis of deuterium events due to the Fermi motion are discussed. Further, the influence of the final-state neutron-proton interaction is presented in detail. Application is made to the reaction $\bar{p}d \rightarrow \bar{p}pn$. (auth)

8397 MULTIPLICITY DISTRIBUTIONS AND THE MULTIPERIPHERAL MODEL. Kisielewska, D. (Inst. of Nuclear Techniques, Krakow); Loskiewicz, J. Nucl. Phys.; B49: 29-39 (1972).

The experimental data on multiplicity distributions in πp interactions are compared with multi-Regge model (MRM) predictions. It is shown that the versions of MRM with a single pole as the leading singularity do not describe the experimental data correctly. In most cases the high multiplicity tail is underestimated by the model. This may mean that some additional mechanism is present at low two-particle "sub-energies." In such a case the use of energy-independent isospin factors seems unjustified. (auth)

8398 ESTIMATES OF WEAK STRANGE PARTICLE PRODUCTION. Beder, D. S. (Univ. of British Columbia, Vancouver). Nucl. Phys.; B49: 45-51(1972).

Motivated by the imminent operation of high-intensity "meson factories," the rates for weak production of K and Λ at low energies, via the reactions $np \rightarrow \Lambda p$ and $\pi p \rightarrow Kp$, are estimated. The premise is dominance of the amplitudes by various "exchanges" and the typical result is $d\sigma/d\Omega \approx 10^{-40}$ cm^2/sr at 500 to 700 MeV lab k.e. of the projectile. (auth)

8399 PHASE-SHIFT ANALYSIS. Beiner, J. pp 2.71-2 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The partial wave expansion of the π-N scattering amplitude is considered; a method for determining the phase shifts that fit the measured values of the differential and total cross sections is presented. (France)

8400 DIFFRACTIVE DISSOCIATION OF PARTICLES THROUGH COLLECTIVE EXCITATIONS. Hama, Y. (Univ., Turin). Phys. Rev., D; 6: No. 11, 3306-25(1 Dec 1972).

A model of diffractive dissociation is proposed in which these reactions are regarded as occurring through two stages: (i) coherent excitation of one (or both) of the incident particles as a whole, and (ii) subsequent decay of the excited states which occurs independently of (i). This assures the observed constancy of the average multiplicity of the dissociated systems $\langle n \rangle$ as a function of the four-momentum transfer t. With an additional assumption of an extended-particle eikonal approximation in $\langle i \rangle$ and a statistical hypothesis in (ii), the model describes satisfactorily all the essential features of diffractive dissociation. (auth)

8401 COMPLEX-REGGE POLE MODEL CONSISTENT WITH THE DUAL ABSORPTION PICTURE: MESON–BARYON CHARGE-EXCHANGE REACTIONS. Barik, N.; Desai, B. R. (Univ. of California, Riverside). Phys. Rev., D; 6: No. 11, 3192-3209(1 Dec 1972).

The reactions $\pi^-p \rightarrow \pi^0n$, $\pi^-p \rightarrow \eta n$, $K^-p \rightarrow \bar{K}^0n$, and $K^+n \rightarrow K^0p$, where ρ and/or A_2 exchanges are involved, are considered within the complex-pole model with the amplitudes given by $\gamma_+\xi_+s^{\alpha_+} + \gamma_-\xi_-s^{\alpha_-}$. The fits confirm the prediction of the dual absorption model in that the real part of the residue function, γ_R, is found to be $\sim J_n$ with n = 0, 1. For the imaginary part, γ_I, it is found that since the j-plane cuts are strong for the spin-nonflip amplitude then $\gamma_I \sim -H_0$, the Struve function, whereas the cuts are weak for the spin-flip amplitude so that $\gamma_I \sim 0$. The contribution of γ_I to the amplitude always appears in the form $\alpha_1\gamma_I$, which is quite small. Good quantitative fits to all the data are obtained in terms of only four parameters for the exchange-degenerate ρ, A_2 residue if we take $J_0(R_0(-t)^{1/2}) \mp iH_0(R_0(-t)^{1/2})$ as the nonflip residue and $J_1(R_1(-t)^{1/2})/R_1(-t)^{1/2} \mp i\lambda\alpha_1$ as the flip residue with $R_0 \approx R_0' \approx R_1 \approx 1$ F and $\lambda < 1$. For the imaginary part of the trajectory function $\langle\alpha_I\rangle_\rho = 0.17$ and $\langle\alpha_I\rangle_A = 0.26$. The presence of nonzero α_I removes the need for any explicit ghost-eliminating factors. A detailed discussion of this model as well as a comparison with other models is made. (auth)

8402 COMPLEX-REGGE-POLE MODEL IN πN SCATTERING. Park, R. T. (California State Univ., Northridge); Barik, N.; Gregorich, D. T. Phys. Rev., D; 6: No. 11, 3162-70(1 Dec 1972).

The complex-Regge-pole model is applied to πN elastic and charge-exchange scattering in the forward direction. P, P', and ρ poles are assumed to dominate with both square-root and logarithmic singularity at the branch point. The Pomeranchuk trajectory is parametrized both as a real pole and as a pair of complex-conjugate poles. Various ghost-eliminating mechanisms are tested, and good fits are obtained including excellent agreement with the new πN charge-exchange and elastic polarization data. P' and ρ are nearly exchange degenerate, but the data show no strong preference for either a real or complex Pomeranchuk trajectory or for a square-root or logarithmic branch cut. (auth)

8403 INTERPRETATION OF THE $Y_0^*(1405)$ RESONANCE. Dobson, P. N. Jr.; McElhaney, R. (Univ. of Hawaii, Honolulu). Phys. Rev., D; 6: No. 11, 3256-9(1 Dec 1972).

An attempt is made to show that the interpretation of the $Y_0^*(1405)$ resonance as a bound state of quarks is not ruled out by the data presently available. The results, however, also indicate that such an interpretation does not answer some of the objections that have been raised to the more conventional picture of this resonance as $\bar{K}N$ bound state. (auth)

8404 PLOT SHOWING CHARACTERISTICS OF AN INCLUSIVE PROCESS IN MANY LORENTZ FRAMES. Biswas, N. N. (Univ. of Notre Dame, IN). Phys. Rev., D; 6: No. 11, 3127-9(1 Dec 1972).

A two-dimensional plot is suggested for the study of an inclusive process. In this plot, the characteristics of particle spectra in all Lorentz frames translated along the incident beam direction can be visualized. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 8439, 8440, 8461, 8721, and 8740.

8405 (INP–807) POTENTIAL DESCRIPTION OF THE PROTON–PROTON SCATTERING IN THE LABORATORY MOMENTUM RANGE FROM 1 TO 20 GeV/c. Budzanowski, A.; Dymarz, R.; Grotowski, K.; Kwiatkowski, K.; Strzalkowski, A. (Institute of Nuclear Physics, Krakow (Poland)). Jul 1972. 44p. Dep. NTIS (U. S. Sales Only).

Most of the high energy elastic proton–proton scattering data (such as differential cross section in the whole range of momentum transfer, total cross section, the ratio of the real to the imaginary part of the forward elastic scattering amplitude) are used to determine the features of the optical model potential in a wide range of the laboratory momentum of incident protons from 1 to 20 GeV/c. It was assumed that protons can be treated as spinless particles and that their interaction may be described by the two-body Klein–Gordon equation in the center-of-mass system. Three components with the Gaussian shape form the real part of the potential while the imaginary part has the Saxon–Woods form factor. At lower energies the real part of the potential consists of a repulsive few-GeV soft-core surrounded by an attractive well. At higher energies the real potential is repulsive for all internucleon distances. The energy dependence of the potential is given by a simple parameterization describing well the experimental data. (auth)

8406 SPECULATION FOR DEEPLY INELASTIC–ELASTIC COLLISIONS. Muraki, Y.; Nakagawa, M. (Nagoya Univ., Japan). pp 1229-33 of 12th International Conference on Cosmic Rays, Vol. 3, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 3).

The differential cross section on the square of the four momentum transfer t for the over-all inelastic pp collisions is presented. Based on this fact, a speculation for the dynamical natures of the deeply inelastic and elastic collisions is given. (Australia)

8407 t/s SCALING IN STRONG INTERACTIONS. Horn, D.; Moshe, M. (Tel-Aviv Univ., Israel). Nucl. Phys.; B48: No. 2, 557-72(1972).

The phenomena of t/s scaling in proton–proton scattering is discussed. After a theoretical introduction based on a parton approach the data are analyzed and the scaling properties are shown. The parton model leads to similar expressions for the inclusive productions of protons. (auth)

8408 ELASTIC pd SCATTERING AT 316, 364, 470, AND 590 MeV IN THE BACKWARD HEMISPHERE. Alder, J. C.; Dollhoff, W.; Lunke, C.; (and others) (Lewis Research Center, Cleveland). Phys. Rev., C; 6: No. 6, 2010-19(Dec 1972).

The elastic pd differential cross section for center-of-mass angles between 91 and 164° was investigated at energies of 316, 364, 470, and 590 MeV. For center-of-mass scattering angles larger than 130°, the cross sections at any given angle are within 10% of each other for the three largest energies. The extrapolated 180° differential cross section observed in this experiment remains nearly constant from 316 to 590 MeV. This is in marked contrast to the rapid decrease in cross section with increasing energy observed by other investigators for both larger

and smaller energies. Possible theoretical explanations of this behavior are mentioned. (5 figures, 4 tables) (auth)

8409 NUCLEON–NUCLEON SCATTERING AND THE KADYSHEVSKII EQUATION. Bawin, M.; Lavine, J. P. (Univ., Liege). Nucl. Phys.; B49: 610-20(1972).

A three-dimensional relativistic wave equation given by Kadyshevsky is investigated. This equation has been applied recently to nucleon–nucleon and to pion–nucleon scattering. The Kadyshevsky equation is solved for phenomenological nucleon–nucleon potentials for uncoupled s-waves. The resulting phase shifts differ from the Lippmann-Schwinger phase shifts by 7% or less for superpositions of two and three Yukawa-like potentials. The relativistic corrections differ from those obtained by other authors with the Bethe-Salpeter equation in the ladder approximation and the Blankenbecler-Sugar-Logunov-Tavkhelidze equation. It was also found that the coupling constants must be changed by about 4% in order to reproduce the nonrelativistic phase shifts at low energy. On the one hand, the results indicate that the Kadyshevsky equation is a bad approximation to the Bethe–Salpeter equation for the nucleon–nucleon problem. Alternatively, since the Bethe–Salpeter equation in the ladder approximation is not fundamental, they show that relativistic corrections crucially depend on the relativistic model chosen. (auth)

8410 EFFECT OF ΛΣ CONVERSION IN HYPERNUCLEAR MATTER. Satoh, E. (Tokyo Inst. of Tech.). Nucl. Phys.; B49: 489-500(1972).

The effect of the ΛΣ conversion on the Λ particle binding in infinite nuclear matter is estimated by using phenomenological separable potentials of the Yamaguchi type which permit exact analytical solutions of the Bethe–Goldstone equation as well as those of the Schrödinger equation for the YN scattering. All the potentials for one-channel (OCF) and two-channel (TCF) formalisms are assumed to be central. They are equivalent in the sense that they lead to the same low energy ΛN scattering phase shift. Furthermore, in order to remove the arbitrariness of the potentials for TCF, one requires them to reproduce the Λp ^3S resonance below the ΣN threshold and also to reproduce the elastic and inelastic cross sections for Σ^-p. More realistic form factors for the interaction than those in previous papers are taken in these potentials for TCF. The calculated elastic and inelastic cross sections for Σ^-p, which are very crucial to set up the potentials for TCF, are in good agreement with experimental data. The potentials reproduce almost perfectly the Λp resonance. (auth)

8411 RADIATIVE TAIL FOR THE PROCESS pp → π^+d NEAR THRESHOLD. Picciotto, C.; Tanaka, S. (Univ. of Victoria, B. C.). Nucl. Phys.; B49: 40-4(1972).

A calculation of the cross section for the process pp → π^+dγ near threshold is presented, showing the contribution of this process to the pion spectrum near the deuteron peak. The results of such a calculation should be useful when looking at the pion spectrum with high resolution, since in that case one should be able to identify all the processes that contribute to the spectrum. It is found that the values are too small to be important near threshold, and larger but still not very significant at higher energies (~600 MeV). (auth)

8412 RELATIVISTIC MODEL FOR NUCLEON–NUCLEON SCATTERING INCLUDING TWO-PION-EXCHANGE. Haracz, R. D. (Drexel Univ., Philadelphia); Thompson, R. H. Nucl. Phys.; B49: 141-58(1972).

A relativistic model for elastic nucleon–nucleon (N–N) scattering is constructed using the Blankenbecler-Sugar method and the two-pion exchange (TPE) contribution to the K-matrix. Two different models (field theory and dispersion relation) are considered to describe TPE. The inner region or core of the interaction, specified by S, P and $^3D_1$ phases, is treated using the Blankenbecler-Sugar equation, while the outer region or tail of the interaction is established by adding the TPE effect. Good agreement with the experimental phase parameters is attained, and the models are in good agreement with certain of the various phase-shift analyses considered where these show marked differences. A realistic ε (J = T = 0 scalar meson) mass is used in the calculation, and the short range behavior of the interaction is fixed using pion-nucleon data and a simple phenomenological model for the meson-nucleon vertex function. (auth)

8413 SOME RIGOROUS INEQUALITIES FOR S-, P-, AND D-WAVES IN π–π SCATTERING. Gislen, L.; Johannesson, N. (Lund Univ., Sweden). Nucl. Phys.; B49: 358-64(1972).

Inequalities for S, P and D ππ partial waves are derived using crossing symmetry and positivity. (auth)

8414 TWO-PARTICLE EXCLUSIVE CORRELATIONS AT 23 GeV/c COMPARED WITH A DIFFRACTION EXCITATION AND A MULTIPERIPHERAL MODEL. Lyon, D. E. Jr.; Yao, Y. P. (Univ. of Michigan, Ann Arbor). Phys. Rev., D; 6: No. 11, 3129-35(1 Dec 1972).

Two-particle correlations in the process p + p → p + p + π^+ + π^+ + π^- + π^- at 23-GeV/c incident momentum are analyzed with a diffraction excitation model, and a Reggeized multiperipheral model that contains symmetrization and baryon exchange. The former provides a slightly better description of the correlation data. Some single-particle distribution model calculations are presented and discussed. (auth)

8415 MODEL FOR PRODUCTION OF π^+ AND π^- BY PROTONS FROM NUCLEI. Sternheim, M. M.; Silbar, R. R. (Los Alamos Scientific Lab., NM). Phys. Rev., D; 6: No. 11, 3117-26(1 Dec 1972).

The conventional semiclassical model for pion production from nuclei is modified by including charge exchange of the outgoing pions and by dropping the forward-production approximation. Good agreement is found with the general features of the π^+ and π^- production by 740-MeV protons from various nuclei, as measured recently by Cochran et al. (auth)

Particle Invariance Principles and Symmetries

General

8416 (JINR–E2-6646) HARMONIC ANALYSIS ON THE LORENTZ GROUP AND PARTICLES WITH SPIN IN QUASIPOTENTIAL APPROACH. Mavrodiev, S. C.; Skachkov, N. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 22p. Dep. NTIS (U. S. Sales Only).

The Shapiro transformation for the case of an arbitrary spin is obtained in the parameterization suitable for quasipotential approach. Addition theorem was also obtained for transformation nuclei. An example of the local quasipotential in the relativistic configuration space is given. (auth)

8417 (NP–19607) FIELDS, STATISTICS, AND NON ABELIAN GAUGE GROUPS. Note No. 387. Doplicher, S.; Roberts, J. E. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 28 Jun 1972. 33p. Dep. NTIS (U. S. Sales Only).

Field theories are examined with a compact group G of exact internal gauge symmetries so that the superselection sectors are labelled by the inequivalent irreducible representations of G. A particle in one of these sectors obeys a parastatistics of order d if and only if the corresponding representation of G is d-dimensional. The correspondence between representations of the observable algebra and representations of G extends to a mapping of the intertwining operators for these representations preserving linearity, tensor products and conjugation. Although one assumes no explicit commutation property between fields, the commutation relations of fields of the same irreducible tensor character under G at spacelike separations are largely determined by the statistics parameter of the corresponding sector. For fields of conjugate irreducible tensor character the observable part of the commutator (anti commutator) vanishes at spacelike separations if the corresponding sector has para-Bose (para-Fermi) statistics. (auth)

8418 REPRESENTATIONS OF THE BONDI–METZNER–SACHS GROUP. 1. DETERMINATION OF THE REPRESENTATIONS. McCarthy, P. J. (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A; 330: No. 1583, 517-35(7 Nov 1972).

Following a historical introduction, it is suggested that irreducible unitary representations of the Bondi–Metzner–Sachs group may be used to classify elementary particles in a quantum theory which takes "asymptotically flat" gravitational fields into account. The unitary representations of the group induced from irreducible unitary representations of the connected little groups are all determined. It is shown that the connected little groups are all compact, so that the "spins" of the corresponding particles are necessarily discrete, and the wavefunctions have a finite number of components. Furthermore, the spins are of precisely the observed type. This is in striking contrast to the situation for the Poincare group, for which the spins may be discrete or continuous. It is concluded that the B.M.S. group may provide an explanation for the observed discreteness of the spins of elementary particles. (auth)

8419 DEFINITE SCALE DIMENSIONS OF THE AXIAL CURRENT COMPONENTS EXPLOITED IN A LOCAL SATURATION SCHEME. Gromes, D.; Schmidt, M. G.; Stamatescu, I. O. (Univ., Heidelberg). Nucl. Phys.; B48: No. 2, 461-75(1972).

The scale dimensions of the space and time components, and of the divergence of the non-strange axial-vector current are studied. A local saturation technique is applied to the relevant commutators. In a pole approximation the energy-momentum tensor is dominated by the σ and the f meson; the formalism can be easily extended to the more realistic case of continuum intermediate states. The assumption of definite dimensions leads to equations for these dimensions and to further relations. These are discussed especially with respect to PCAC. Consequences for the dimension of the SU(2) × SU(2) symmetry-breaking part of the Hamiltonian are considered in connection with the Σ-commutator. (auth)

8420 SPACE INVERSION, TIME REVERSAL, AND PARTICLE ANTIPARTICLE CONJUGATION. Lee, T. D. (Columbia Univ., New York). pp 91-104 of Belfer Graduate School of Science Annual Science Conference Proceedings. Vol. 2. /Gelbart, A. (ed.). New York; Marcel Dekker, Inc. (1969).

The evolution of the concepts of the discrete symmetry operations of parity, time reversal, and charge conjugation invariance is reviewed. P and T in classical mechanics, parity nonconservation, time reversal invariance, CPT invariance and the relations between particles and antiparticles, the strong interaction C invariance, and the nature of charge conjugation are covered. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstract 8270.

8421 FORM FACTORS OF K_{l_3}-DECAY AND THE OCTET SYMMETRY BREAKING IN THE SU_3 SIGMA MODEL. Natroshvili, K. R.; Khelashvili, A. A. Soobshch. Akad. Nauk Gruz. SSR; 68: No. 2, 317-20(Nov 1972). (In Russian).

The scalar form factor of K_{l_3} decay is investigated in the frame of the SU_3 sigma model for 0^+-mesons when the symmetry-breaking Hamiltonian does not contain more than quadratic degrees of fields. In the tree-graph approximation a general expression is derived for the scalar form factor. Particular cases of symmetry breaking are considered, and it is shown that the (1.8) ⊕ (8.1) representation can not play a decisive role. (auth)

8422 LEPTON–HADRON SYMMETRY BREAKING AND THE CABIBBO ROTATION. Palmer, W. F. (Ohio State Univ., Columbus). Phys. Rev., D; 6: No. 10, 2897-2900(15 Nov 1972).

It is shown that spontaneous breakdown of gauge-invariant $SU(2)_L \times U(1)$ lepton-hadron theories can induce hadron chiral-symmetry-breaking terms consistent with parity and hypercharge conservation and with earlier results of the (3,3*) + (3*,3) model. The theories limit to SU(2) × SU(2) for hadrons, zero Cabibbo angle, and no isospin-breaking term (u_3) when the cross coupling between leptons and hadrons is removed or when the $SU(2)_L \times U(1)$ gauge symmetry is realized without spontaneous breakdown. The Cabibbo angle is not constrained. (auth)

8423 (6,6*) ⊕ (6*,6) REPRESENTATION OF SU(3) ⊗ SU(3) AND THE BREAKING OF CHIRAL SYMMETRY. Auvil, P. R. (Stanford Univ., CA). Phys. Rev., D; 6: No. 11, 3209-16(1 Dec 1972).

The (6,6*) ⊕ (6*,6) representation of SU(3) ⊗ SU(3) is presented and its use in breaking chiral symmetry is discussed in terms of its contribution to meson masses, pion-pion scattering lengths, baryon masses, and the nucleon σ term. Singlet, octet, and 27-plet SU(3) pieces are included in the symmetry-breaking Hamiltonian, and the possible SU(2) ⊗ SU(2) classifications of the Hamiltonian are discussed. (auth)

8424 UPPER LIMIT ON THE CP-VIOLATION EFFECT IN NONLEPTONIC DECAYS OF HYPERONS AND ANTIHYPERONS. Pham, T. N.; Truong, T. N. (Centre de Physique Theorique de l'Ecole Polytechnique, Paris). Phys. Rev., D; 6: No. 11, 3348-51(1 Dec 1972).

A phenomenological analysis of the CP-violation effect in hyperon-antihyperon nonleptonic decays is made. The following bounds are obtained: (i) $|\sin \tfrac{1}{2}(\Delta_1 - \Delta_3)| \leq 0.61^{+0.27}_{-0.0}$, where $(\Delta_1 - \Delta_3)$ is the CP-violation phase; (ii) $\gamma(\Sigma^+ \to n\pi^+) \geq -0.971 + 0.003$; and (iii) $[|\Gamma(\Sigma^+ \to n\pi^+) - \Gamma(\bar{\Sigma}^+ \to \bar{n}\pi^-)|]/[\Gamma(\Sigma^+ \to n\pi^+) + \Gamma(\Sigma^+ \to p\pi^0)] \lesssim 7\%$. (auth)

8425 IMPROVED TEST OF CPT INVARIANCE IN NEUTRAL-KAON DECAYS. Dass, G. V. (Deutsches Elektronen Synchrotron, Hamburg); Kabir, P. K. Phys. Rev., D; 6: No. 11, 3326-9(1 Dec 1972).

A measurement by Morse et al. is reanalyzed and combined with earlier measurements to improve existing limits on $\mathrm{Re}\delta = \tfrac{1}{2}(\epsilon_S - \epsilon_L)$, a measure of possible deviation from CPT invariance in the neutral-kaon system. Some of the possible methods to further improve the limits on this parameter are reviewed. (auth)

8426 CHIRAL SYMMETRY BREAKING AND THE CABIBBO ANGLE. Genz, H. (Univ., Karlsruhe, Ger.); Katz, J.; Ram Mohan, L. R.; Tatur, S. Phys. Rev., D; 6: No. 11, 3259-65(1 Dec 1972).

The proposal of Oakes linking the pion mass and the strangeness-changing weak interactions is investigated in the (8,8) symmetry breaking of SU(3) ⊗ SU(3). This leads to a determination of the Cabibbo angle and the $\eta \to 3\pi$ decay rates which are in agreement with the earlier results in the $(3,\bar{3}) \oplus (\bar{3},3)$ model. The connection between cancellations in the leading weak-interaction divergences and the Cabibbo angle, however, does not hold in the (8,8) scheme. (auth)

8427 SYMMETRIES AND THE $K_S \to \mu^+\mu^-$ BRANCHING RATIO. Dass, G. V. (DESY, Hamburg). Nucl. Phys.; B49: 109-27(1972).

Implications of the low experimental $K_L \to \mu^+\mu^-$ decay rate, and of CP, T and CPT invariances, for the $K_S \to \mu^+\mu^-$ branching ratio are considered. In the spirit of economy, physical (energy-conserving) kaon decay amplitudes for the strongly coupled channels $\pi\pi$ and $\gamma\gamma$ are taken to be CP, T and CPT invariant, but those for the very feeble channel $\mu^+\mu^-$ are allowed to contain non-invariant pieces in only their dispersive parts. Then, the lower bound on the $K_S \to \mu^+\mu^-$ branching ratio is 10^{-6}, zero and 10^{-6} respectively for the case of only T-invariance, of only CP invariance, and of only CPT invariance for the $K \to \mu^+\mu^-$ dispersive amplitudes. The last value was obtained previously under somewhat different assumptions. Lower bounds on the $K_S \to \mu^+\mu^-$ branching ratio were previously derived in a CPT invariant description, without assuming CP invariance. A systematic discussion is given of the modifications in all these bounds if possible CPT non-invariant contributions were present, either in the $K^0 - \bar{K}^0$ mass matrix, or in kaon decay amplitudes as restricted in the above economical scheme. Some of the previous bounds are lost, some get only quantitatively changed, and others are unaffected. In particular, with the $K \to \pi\pi$, $\gamma\gamma$ assumption above, the bound is 5×10^{-7}, allowing the most general $K \to \mu^+\mu^-$ amplitudes, if the imaginary part of the CP conserving total $K \to \mu^+\mu^-({}^1S_0)$ amplitude is determined by the unitarity contribution of the $\gamma\gamma$ intermediate state. Beyond the economical scheme, weakenings of all the above bounds if the mass-matrix parameter needed to derive these bounds is taken directly from experiment, rather than being determined through a theoretical assumption, are also considered. In particular, the weakenings of the existing CPT invariant bounds if the mass-matrix parameters are taken from data, rather than assume CPT invariance, are given. As an illustrative example, the lowest existing bound 2×10^{-7} is weakened to 0.08×10^{-7}. (auth)

Applications (Strong)

8428 (JINR–P2-6690) MASS FORMULAE IN SU(3)-SYMMETRY WITH ELLIPTICAL BASIS. Lukach, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The mass formula in SU(3) symmetry with elliptical basis, involving the mass splitting of supermultiplets simultaneously by strong and electromagnetic interactions, is obtained. The mass spectrum of baryon octet and decuplet is considered. The new sum rules for the masses of particles in supermultiplets are found. (auth)

8429 EXACT SU(3) SYMMETRY AND UNITARITY OF THE S MATRIX OF HYPERON–NUCLEON INTERACTIONS. Warenghem, Marc; Cortois, Jean (Lille Univ., Villeneuve-d'Ascq, France). Compt. Rend., Ser. B; 275: No. 11, 369-72(11 Sep 1972). (In French).

The exact SU(3) symmetry as well as the unitarity of the S matrix are used to obtain a relation between the elements of this matrix for the three channel problem ($\Sigma^-p \to \Sigma^-p$ or Λn or $\Sigma^0 n$). It is demonstrated that five real parameters are sufficient to determine the S matrix of this problem. (France)

8430 APPROXIMATE HIGHER SYMMETRIES OF STRONG INTERACTIONS. Guersey, F. (Yale Univ., New Haven). pp 41-59 of Belfer Graduate School of Science Annual Science Conference Proceedings. Vol. 2. /Gelbart, A. (ed.). New York; Marcel Dekker, Inc. (1969).

The treatment covers SU(6) multiplets and mass formulas, the baryon–meson vertex in the absence of internal symmetries, relativistic relations among form factors, and the relativistic SU(6) invariant baryon–meson vertex. Good results are obtained for the low-lying hadron spectrum, mass sum rules, and the vertex. (J.F.P.)

8431 ESTIMATION OF THE VACUUM SU(3) BREAKING IN THE $(3,\bar{3}) + (\bar{3},3)$ MODEL. Cornwell, D. T. (Univ., Hamburg); Eimerl, D. Nucl. Phys.; B49: 61-70(1972).

It is pointed out that the usual $(3,\bar{3}) + (\bar{3},3)$ model of chiral symmetry breaking and recent mathematical analyses of the parameters in K_{l3} decay restrict the possible value of $\Delta_K(0)$, the generalized propagator of the strangeness-changing vector divergence at zero four momentum squared. The requirement of approximate SU(3) invariance of the vacuum reduces the allowed range of values still more. When this parameter is then evaluated using fits to the $K\pi$ phase-shift data, it is found to fall outside the available interval. Therefore it is concluded that, within this scheme, the $K\pi$ scattering data is incompatible with the SU(3) symmetry of the vacuum. Possible ways of avoiding this conclusion, or of altering the scheme, are considered. (auth)

8432 $(6,\bar{6}) + (\bar{6},6)$ SYMMETRY BREAKING IN CHIRAL $SU(3) \times SU(3)$. Dittner, P. (Imperial Coll. of Science and Tech., London); Eliezer, S.; Dondi, P. H. Nucl. Phys.; B49: 242-52 (1972).

The features of a model where the $SU(3) \times SU(3)$ symmetry breaking Hamiltonian transforms according to the $(6,\bar{6}) + (\bar{6},6)$ representation are investigated. The $\pi\pi$ s-wave scattering lengths are calculated and the πN sigma term is considered in relation to the baryon masses. The K_{l3} problem is also discussed. The results are compared with the $(3,\bar{3}) + (\bar{3},3)$ and (8,8) models of symmetry breaking. (auth)

Field Theories

Quantum Field Theory

Refer also to abstracts 8376 and 8462.

8433 (JINR-P2-6593) QUASI-POTENTIAL EQUATION IN TWO-DIMENSIONAL MODEL OF FIELD THEORY. Kerimov, G. A.; Mir-Kasimov, R. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

Different aspects of the quasi-potential approach are considered in the frame of two-dimensional scalar field theory. The analytic properties of the scattering amplitude are studied. The exact solutions are represented for a number of simple potentials. (auth)

8434 APPARENT VISUAL FORMS OF RELATIVISTICALLY MOVING OBJECTS. Mathews, P. M.; Lakshmanan, M. (Univ. of Madras). Nuovo Cim.; 12B: No. 1, 168-81(11 Nov 1972).

The question of the apparent visual shape of an object moving at relativistic speeds, as perceived by a single observer, is analyzed afresh. It is shown by qualitative arguments that the apparent shape is related to the shape at rest through a combination of nonuniform shear and extension/contraction parallel to the direction of motion, which does not reduce to a rotation even in the case of distant objects subtending a small angle at the observer. The two-dimensional projection (as in a photograph) of this distorted shape may coincide with that of the object (suitably rotated) at rest; but we emphasize that it would be grossly misleading to conclude from this, as is generally done in the literature, that distant relativistically moving objects appear as if simply rotated. The "train paradox" is discussed in illustration of this point. Analytical formulas relating the apparent visual shape to the shape at rest are given. Also the striking fact that the apparent speed of the object as seen by visual observation may well exceed the speed of light is brought out. Finally it is pointed out that the phenomenon is closely analogous to the relativistic Doppler effect. (auth)

8435 DIMENSIONAL RENORMALIZATION: THE NUMBER OF DIMENSIONS AS A REGULARIZING PARAMETER. Bollini, C. G.; Giambiagi, J. J. (Univ. Nacional, La Plata). Nuovo Cim.; 12B: No. 1, 20-6(11 Nov 1972).

An analytic extension of quantum electrodynamics matrix elements as (analytic) functions of the number of dimensions of space (v) is performed. The usual divergences appear as poles for v integer. The renormalization of those matrix elements (for v arbitrary) leads to expressions which are free of ultraviolet divergences for v equal to 4. This shows that v can be used as an analytic regularizing parameter with advantages over the usual analytic regularization method. In particular, gauge invariance is maintained for any v. (auth)

8436 OPERATORS ON THE FOCK SPACE, DIAGONAL IN THE WAVE-PACKET FORMALISM AND IN THE MODE REPRESENTATION. Benard, Christine (Paris Univ., Orsay, France). Z. Phys.; 256: No. 4, 316-22(1972).

The conditions that an operator on the Fock space, diagonal in the mode representation, must verify to have a diagonal form in the wave-packet (W.P.) formalism are established, and it is shown that, if these conditions are verified, there is only one set of W.P. on which such a given operator is diagonal. The interest of these results lies in the probabilistic interpretation of a diagonal density matrix in the W.P. formalism; indeed a field described by such a density matrix may be considered as a mixture of one particle W.P. In particular the results apply to chaotic density matrices and prove that there is one way only of describing a given chaotic field as a mixture of one particle W.P. (auth)

8437 CONSTRAINTS ON ANOMALIES. Adler, S. L. (Inst. for Advanced Study, Princeton, N. J.); Callan, C. G. Jr.; Gross, D. J.; Jackiw, R. Phys. Rev., D; 6: No. 10, 2982-8(15 Nov 1972).

The various coupling-constant-dependent numbers describing anomalous commutators are constrained by the nonrenormalization of the axial-vector-current anomaly. The axial-vector current continues to behave anomalously even if the underlying unrenormalized field theory is finite due to the vanishing of the Gell-Mann-Low eigenvalue function. (auth)

8438 LORENTZ-INVARIANT FORMULATION OF CHERENKOV RADIATION BY TACHYONS. Jones, F. C. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., D; 6: No. 10, 2727-35(15 Nov 1972).

Previous treatments of Cherenkov radiation by tachyons have been in error because the prescription employed to cut off the divergent integral over frequency, namely $\omega_{max} = E/\hbar$, is not a Lorentz-invariant procedure. The resulting equation of motion for the tachyon is therefore not covariant. The proper procedure requires an extended, deformable distribution of charge and yields a particularly simple form for the tachyon's world line. A simple, covariant equation of motion is derived that describes the motion of a charged tachyon that is emitting Cherenkov radiation. It is shown that Cherenkov radiation by tachyons implies their ultimate annihilation with an antitachyon and demonstrates a disturbing property of tachyons, namely, the impossibility of specifying arbitrary Cauchy data even in a purely classical theory. (auth)

8439 STATIC LIMIT OF FIELD THEORIES. I. Fronsdal, C.; Huff, R. W. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 6: No. 10, 2755-60(15 Nov 1972).

The field equations for two nonidentical massive isospinor fields, interacting through the exchange of massive isovector mesons, are solved in the static limit. The solution describes two infinitely heavy isospinor particles, fixed a distance r apart, exchanging isovector mesons with mass μ. The effective Hamiltonian is the Born-Oppenheimer potential. It shows significant departure from the Yukawa potential when μr is of the order of the coupling strength or less. The case of spinor particles with gradient coupling to pseudoscalar mesons is also solved. (auth)

8440 STATIC LIMIT OF FIELD THEORIES. II. γ_5 THEORY. Fronsdal, C.; Huff, R. W. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 6: No. 10, 2760-3 (15 Nov 1972).

The static limit of a pseudoscalar symmetric meson theory of nuclear forces is examined. The Born-Oppenheimer potential is determined for the case of two very heavy nucleons exchanging pseudoscalar isovector pions with pseudoscalar coupling. The very considerable difference between this potential and the Yukawa potential at distances of about 1 F is due to the nonlinear terms induced by the γ_5 coupling, and in much smaller measure to spin and isospin inertia. A direct confrontation with low-energy nucleon-nucleon scattering data is suggested. (auth)

8441 RIGOROUS BOUNDS ON COUPLING CONSTANTS IN TWO-DIMENSIONAL FIELD THEORIES. Creutz, Michael (Univ. of Maryland, College Park). Phys. Rev., D; 6: No. 10, 2763-5(15 Nov 1972).

It is shown that renormalized three-particle coupling constants in a field theory with one space and one time dimension are bounded. This bound depends on the particle spectrum and assumes only analyticity, crossing, unitarity, and polynomial boundedness of the S matrix at infinity. (auth)

8442 QUASISECULAR PERTURBATIVE METHOD FOR CALCULATING BOUND STATES IN QUANTUM FIELD THEORY. Aks, S. O.; Varga, B. B. (Univ. of Illinois, Chicago). Phys. Rev., D; 6: No. 10, 2773-9(15 Nov 1972).

A calculational procedure is given for determining bound states in quantum field theory using an approximation to the field determined from the equations of motion by the method of quasi-secular perturbation theory. The method is illustrated using the ϕ^4 model of quantum field theory. Although the procedure is based on a perturbation theory, it leads to binding energies which are nonanalytic in the coupling constant. The bound state occurs for

arbitrarily weak coupling in the cases of one and two space dimensions, but not for three. Comparison is made with the Bethe–Salpeter equation in the ladder approximation. The result agrees for one dimension, but differs for two and three. (auth)

8443 HIGH-ENERGY BEHAVIOR IN A MODEL NONPOLYNOMIAL LAGRANGIAN FIELD THEORY. Lazarides, G. (Imperial Coll. of Science and Tech., London); Patani, A. A.; Shafi, Q. Phys. Rev., D; 6: No. 10, 2780-8(15 Nov 1972).

A Lagrangian field theory described by the interaction $\mathfrak{L}_{int} = \frac{1}{2}\lambda\phi^2 (e^{\kappa\theta} - 1)$ is considered where ϕ and θ are scalar fields with masses μ and zero, respectively, and λ, κ are the coupling constants. It is shown that the sum of a particular class of ladder graphs for $\phi\phi \to \phi\phi$ scattering is polynomially bounded in s, the square of the incoming center-of-mass energy. This is true although an individual ladder with n rungs grows like exp $(\sigma_n^n s^n)$ for increasing s. (auth)

8444 SPECTRAL FORMS FOR THREE-POINT FUNCTIONS. Ivanetich, R. J. (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 6: No. 10, 2805-22(15 Nov 1972).

Single- and double-spectral forms for three-point functions are studied, in a detailed manner, within the framework of source theory. The methods developed, which are applicable beyond the present problem, are based on causal considerations and appear to provide some simplifications and advances over the conventional analytic methods. The spectral variables are any one or two of the momentum scalar products $(p_\alpha^2, p_\beta^2, p_\gamma^2)$ on which the three-point function depends, p_α^2 and $p_\alpha^2 - p_\gamma^2$, to be specific. After studying the lowest-order nontrivial contributions, a source-theoretic calculational scheme for contributions of arbitrary order is qualitatively developed, and it is used in establishing the spectral forms for general order. In lowest order the spectral weight functions are explicitly given, while in general order the main concern is the existence of the spectral forms. The spectral forms considered are only ones with normal thresholds, and the methods give regions of those variables not in spectral form $(p_\beta^2 - p_\gamma^2$ and $p_\beta^2)$ for which such spectral forms of general order occur, with all particles being allowed different masses. For the single-spectral studies the region is in agreement with that obtained conventionally. The region for the double-spectral form is all space-like values of p_β^2; double-spectral forms for three-point functions of general order do not appear to have been investigated previously. (auth)

8445 EXPERIMENTAL METHOD FOR DETECTING POSSIBLE NEGATIVE MASSES. Hawecker, X. C. (Institut National de Gravitation, Satory, France). Compt. Rend., Ser. B; 275: No. 11, 373-4(11 Sep 1972). (In French).

Special relativity enables the concept of negative mass to be introduced. General relativity does not contradict this hypothesis. The possibility of proving that such masses exist using a mass spectrograph associated with a Faraday cylinder and an electrometer is discussed. (France)

8446 COVARIANT EXPANSION OF THE CONFORMAL FOUR-POINT FUNCTION. Ferrara, S. (CNEN, Rome); Grillo, A. F.; Parisi, G.; Gatto, R. Nucl. Phys.; B49: 77-98(1972).

The problem of a conformally covariant expansion of the four-point function is solved both in Minkowski and in Euclidean space. The role of shadow singularities is discussed. The expansion is examined for its analyticity properties and the various light-cone limits are performed. Vertex identities are derived in momentum space and simply interpreted. (auth)

8447 REMARKS ON NON-POLYNOMIAL FIELD THEORIES. Sarkar, Sarben (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B49: 173-85(1972).

Non-polynomial field theories for which the fields are only functions of time are primarily investigated. The usual contour integral methods are shown to be unnecessarily ambiguous. The conditions for the validity of the kinking theorem are found not to be entirely consistent. The validity of the extrapolation of such results to the one-time and three-space field theories is discussed. (auth)

8448 CONSERVED AND PARTIALLY CONSERVED CURRENTS ON THE LIGHT CONE. Brandt, R. A. (New York Univ., NY); Preparata, Giuliano. Nucl. Phys.; B49: 365-91 (1972).

It is shown how the constraints of current conservation and partial current conservation can be incorporated on light-cone operator-product expansions. For example, if $J_\mu(x)$ is conserved and $[J_0(x), K(y)]\,\delta(x_0 - y_0) = L(x)\delta^4(x-y)$, then it is shown how the expansion for the T-product $T[J_\mu(x)K(y)]$ can be made manifestly consistent with the operator Ward identity $\partial_x^\mu T[J_\mu(x)K(y)] = L(x)\delta^4(x-y)$. The constructions are presented in the framework of a canonical gluon model, the properties of which are discussed in detail. It is shown that the usual use of canonical commutation relations and field equations is inconsistent with naive scale invariance and the existence of simple local products of fields and discuss ways of resolving this difficulty. As examples, the conserved forms for the expansions of the products $V_\mu^a(x)S^b(y)$ and $V_\mu^a(x)V_\nu^b(y)$ in the gluon model are exhibited. As applications of the results, the K_{l3} and π_{l3} form factors are discussed and the scaling laws and scaling relations in deep inelastic neutrino-nucleon scattering are derived. (auth)

8449 PARASTATISTICS FROM THE SCHWINGER ACTION PRINCIPLE. Bloore, F. J.; Lovely, R. M. (Univ. of Liverpool). Nucl. Phys.; B49: 393-404(1972).

A version of Schwinger's action principle is presented. There are two classes of variations, denoted S and G. The class S consists of generators of allowable variations of the dynamical variables q and the class G consists of allowable additions to the Lagrangian. The Cartesian product S × G must belong to the kernel space of an antisymmetric bilinear map R, so that if S is chosen to be large then G must be small. Different choices of S and G lead to different commutation relations for the q's. If S and G are both required to contain generators N_{ij} of linear transformations of the q's, then the vanishing of $R(N_{ij}, N_{kl})$ implies that the q's obey paracommutation relations. The stationary property of the action is guaranteed by an equation of motion of the usual type provided that the Hamiltonian belongs to the class G. When the q's obey paracommutation relations, $R(N_{ij}, \Gamma)$ vanishes for all Γ. So if S is restricted to linear variations then G (and thus the Hamiltonian) is unrestricted. Conversely, when G is unrestricted, S is restricted to linear variations. (auth)

8450 TRILINEAR COUPLING OF SCALAR BOSONS IN THE SMALL MASS LIMIT. Whippman, M. L. (Univ. of Helsinki). Nucl. Phys.; B49: 458-60(1972).

The coupling constant for the trilinear self-interaction of a scalar field in the limit in which the particle mass goes to zero is studied. By using a rigorous bound on the coupling constant, a conjecture due to Veneziano that the coupling vanishes in this limit. It is shown that there is one class of theories for which our proof breaks down, and some of the properties of this class are discussed. Finally, some speculative reasons why Veneziano's arguments also fail for these theories are given. (auth)

8451 UNIQUENESS OF THE AXIAL ANOMALY. Gottlieb, H. P. W.; Marculescu, S. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B49: 633-43(1972).

Anomalies in Ward identities are defined by means of an effective action and the chiral SU(n) × SU(n) gauge group. The consistency conditions of Wess and Zumino are used to prove that, for a large class of phenomenological Lagrangians, the axial anomaly is unique and coincides with the expression found by Bardeen. (auth)

Gravitation and General Relativity

Refer also to abstracts 8159, 8297, and 8418.

8452 PROPERTIES OF A METRIC FOR CONSERVED PARTICLES. Williams, J. G. (Univ. of Birmingham, Eng.). Nuovo Cim.; 12B: No. 1, 58-64(11 Nov 1972).

Within the framework of general relativity, it is possible for particlelike structures to exist which are strictly conserved for topological reasons. A metric describing a single particle center at the origin is described. The Christoffel symbols and the time-time component of the energy-momentum tensor are deduced. (auth)

8453 INTEGRATION OF EINSTEIN'S EQUATION FOR ENERGY DENSITY INSIDE A PERFECT FLUID SPHERE. Kuchowicz, B. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 20: No. 7, 603-8(1972).

One of Einstein's equations for a perfect fluid sphere, the equation involving the energy density, was solved in a general manner only in the case of the canonical coordinate system. It is studied now in the isotropic system, and it is reduced to a simple equation with the help of the substitution: $e^h = \xi^4/r^2$, and $x = \ln r$. The equation is solved under various assumptions concerning the density, e.g., $\rho = \rho(\xi)$, or $\rho = \rho(\xi, \xi', \xi'')$. It is also straightforward to derive a general solution of this equation which provides the two functions e^λ and ρ in parametric form. (auth)

8454 CONFORMAL UNIQUENESS OF SCHWARZSCHILD INTERIOR SOLUTION. Chandra, S.; Bahadur, B. (Univ. of Gorakhpur, India). Curr. Sci. (India); 41: No. 22, 805-7(20 Nov 1972).

It is shown that the Schwarzschild interior solution is the only solution of Einstein's equation for perfect fluid distributions which is static and conformally flat. (J.F.P.)

8455 STATIONARY CYLINDRICALLY SYMMETRIC ELECTROVAC FIELDS. Arbex, N.; Som, M. M. (Centro Brasileiro de Pesquisas Fisica, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 18: No. 17, 219-26(1972).

A particular type of exact solutions of Einstein-Maxwell's equations corresponding to stationary cylindrically symmetric electrovac fields is presented. The solutions are linear combinations of static fields with constant coefficients. (auth)

8456 EFFECT OF SCALAR AND VECTOR FIELDS ON THE NATURE OF THE COSMOLOGICAL SINGULARITY. Belinskii, V. A.; Khalatnikov, I. M. (Inst. of Theoretical Physics, Leningrad). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1121-34 (Oct 1972). (In Russian).

The effect of scalar and vector fields on the character of the cosmological singularity is investigated. The fields may either be gravitational (in the sense of the Brans–Dicke ideas) or extraneous physical fields which are sources of an ordinary gravitational field. It is shown that in the presence of only a scalar field the general solution of the gravitational equations possesses a monotonous power asymptotic. However, if a vector field is included on basis of five-dimension geometry concepts, the general solution becomes oscillatory again. (auth)

8457 CONSERVATION OF PARTICLE NUMBERS IN GENERAL RELATIVITY THEORY. Treder, H. J. (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Ann. Phys. (Leipzig); 28: No. 1, 94-6(1972). (In German).

It is shown that the general covariants along with Einstein's principle of equivalence lead to the conclusion that the scalar laws of the special-relativistic physics apply to any Riemann universe. Cosmological speculations about the emergence and the disappearance of particles result from a failure to take the following facts consistently into account: the general relativity and equivalence principle is universally valid for special-relativistic physics at any position in the universe. (H.B.G.)

8458 STUDY OF THE GRAVITON EMISSION PROCESS. Grossiord, J. L. (Univ., Paris). Compt. Rend., Ser. B; 275: No. 11, 365-8(11 Sep 1972). (In French).

The production of gravitons in electron-positron annihilation processes is studied. (France)

Scattering Theory

Refer also to abstracts 8300 and 8433.

8459 RESTRICTED THREE-BODY PROBLEM. Zehnder, E. Zurich; Eidgenoessische Technische Hochschule (1970). 133p. (In German).
Thesis.

Moser's discussion (1962) of the stability of Poincaré orbits of the first type in the restricted three-body problem is considered. A fundamental theorem concerning the canonical mappings of an annulus is applied to Poincaré mappings of transversal sections. The stability of Poincaré orbits of the second type near circular orbits is investigated. A perturbation method is used for solving the time-dependent Hamiltonian equations. (IAA)

8460 BORN APPROXIMATION FOR LOCAL POTENTIALS. Warburton, A. E. A.; Hatfield, R. W. (Univ. of Hull, Eng.). Nuovo Cim.; 12B: No. 1, 72-82(11 Nov 1972).

For any local potential V(r) satisfying $\int_0^\infty |V(r)|r^2dr < \infty$ the partial-wave amplitudes in Born approximation $V_l(k^2)$ are expressed explicitly in terms of either a particular $V_m(q^2)$ for all q^2, or all the $V_m(q^2)$ at a particular energy $q^2 \geq k^2$. (auth)

8461 SUM RULES FOR POTENTIAL SCATTERING. Kirzhnits, D. A.; Takibaev, N. Zh. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 16: No. 2, 435-7(Aug 1972). (In Russian).

Special sum rules may be derived from the theory of potential scattering, and for potentials used in low energy physics comparatively simple relations are obtained. Using explicit expressions for the Jost function, there were derived: the potential decreasing more rapidly than a given linear exponent, the Yukawa potential, and the separable potential. The sum rules obtained are applicable to low energy scattering of nucleons by nucleons. (K.S.W.)

8462 SHADOW CHANNELS IN POTENTIAL THEORY. Shah-Jahan, M. (Atomic Energy Center, Dacca, Bangladesh). Phys. Rev., D; 6: No. 10, 3037-8(15 Nov 1972).

The effect of coupling a shadow channel to a real channel is considered using separable potentials. (auth)

8463 SUM RULES AND BOUNDS ON SCATTERING AMPLITUDES. Savit, R. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 10, 2943-52(15 Nov 1972).

Using sum rules obtained from crossing and analyticity, and unitarity bounds on scattering amplitudes, it is shown how new relations between low-energy and high-energy scattering can be derived. These relations can provide tests of a wide range of theoretical ideas. As examples, several inequalities obtained for π-π and π-N scattering are discussed. For π-π scattering, a number of relations involving the asymptotic behavior of total cross sections are presented, including bounds limiting the size of violations of the Pomeranchuk theorem. Using finite-energy sum rules for π-N scattering, new types of bounds are derived, and it is shown how they can be used to probe such things as the nature of the Pomeranchuk trajectory and the assumption of s-channel helicity conservation. Finally, inequality constraints between partial-wave amplitudes of different isospin are introduced and it is indicated how they can be used to explore the nature of exchange degeneracy, absence of exotics, and duality. (auth)

8464 CUT EFFECTS IN THE MULTI-REGGE BOOTSTRAP. Sittampalam, A. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 6: No. 10, 2884-90(15 Nov 1972).

The single-trajectory version of the model constructed from the multi-Regge integral equation in a factorizable approximation is modified by including a cut in the input. The Regge trajectory and residue functions are bootstrapped, and the results compared with the case of only a pole in the input. The relative contributions of the pole and the elastic $2 \rightarrow 2$ amplitude cut are also examined. (auth)

8465 LOW'S PROBLEM AND ITS INVESTIGATION BY MEANS OF POWER-SERIES EXPANSIONS. Nedelkov, I. P. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 6: No. 10, 2842-52(15 Nov 1972).

Low's problem is understood as a generalization of problems which are solved by dispersion integral equations of Chew and Low, Shirkov, Chew and Mandelstam, and the like. The abstract definition of Low's problem is based on the properties of analyticity, crossing symmetry, and unitarity of the unknown functions $h^\alpha(z)$ which are physically interpreted as partial-wave amplitudes. It is shown that a relevant formulation of the abstract problem of Low can be given by a nonlinear system of algebraic equations. This system can be solved numerically by the classical methods of nonlinear functional analysis, Newton's method, and the method based on the Banach-Cacciopoli theorem. In both cases the calculations are applied directly to $h^\alpha(z)$. This has an advantage over the conventional N/D method in that it is not necessary to control the appearance of zeros in the denominator. Another advantage is the possibility of resolving problems when there are cuts in the physical plane. (auth)

8466 TRIPLE-REGGE VERTEX IN A DUAL RESONANCE MODEL WITH NONLINEAR TRAJECTORIES. Sukhatme, U. P. (Univ. of Washington, Seattle). Phys. Rev., D; 6: No. 10, 2765-72(15 Nov 1972).

Recently, DeTar and Weis studied the analytic structure of the triple-Regge vertex in the Veneziano model. Their conclusions are extended to a wider class of dual resonance models by deriving the triple-Regge vertex in the Baker–Coon theory, which allows both linear and logarithmic trajectories. In particular, it is found that for unit trajectory intercepts, the triple-Regge coupling vanishes at zero momentum transfer. (auth)

8467 PROOF OF THE POMERANCHUK THEOREM AND RELATED THEOREMS DEDUCED FROM UNITARITY. Truong, T. N. (Ecole Polytechnique, Paris); Lam, W. S. Phys. Rev., D; 6: No. 10, 2875-83(15 Nov 1972).

A new general proof of the Pomeranchuk theorem in the form of the average behavior of total cross sections is given. It contains the features of the Martin and Meiman proof and is more precise. By considering the integral of the forward amplitude, this proof can be extended to cover slowly increasing and decreasing total cross sections. The unitarity restriction on the relative behavior of particle-antiparticle total cross sections is studied in general, again without making the smoothness assumption. In particular, using unitarity, it is shown that a modified form of the Pomeranchuk theorem is valid when the total cross sections are asymptotically unbounded. (auth)

8468 DETECTION OF THE POLES OF AN AMPLITUDE: A COMMENT ON A RECENT PAPER. Calucci, G.; Ghirardi, G. C. (Univ., Trieste, Italy). Phys. Rev., D; 6: No. 11, 3346-8 (1 Dec 1972).

With reference to a recent paper of Caprini et al. the problem of extracting the analytic properties of an amplitude from the experimental data is reviewed. It is suggested that even if one uses the experimental data over all the physical energy range, some ambiguities can survive, allowing different fits, with very different analytic properties for the resulting amplitude. (auth)

8469 CONSTRAINTS ON THE PHASE OF SCATTERING AMPLITUDES DUE TO POSITIVITY. Cornille, H. (IPN, Orsay, France); Martin, A. Nucl. Phys.; B49: 413-40(1972).

From the positivity of Legendre-expansion coefficients of the absorptive part of an elastic scattering amplitude, bounds are obtained on the phase of the scattering amplitude. Bounds on the local variation of the phase are also obtained; in the best case, i.e., if the modulus of the amplitude is Hölder continuous of order $\geq 1/2$ a Hölder continuity condition of order $1/4$ for the phase is found, in which the coefficient is explicitly known from the modulus of the amplitude. (auth)

8470 SCATTERING OF PARTICLES WITH SPIN; MACKEY-STATE FORMULATION. Balachandran, A. P. (Syracuse Univ., NY); Nilsson, J.; O'Raifeartaigh, L. Nucl. Phys.; B49: 221-41 (1972).

The conventional states used to describe the scattering of particles with spin are the covariant states and the Wigner states. The scattering of massive particles is described in terms of Mackey states, which are analogous to the states used by Mackey in his induced theory of group representations, and whose advantage is that their Lorentz-transformation law does not involve the spin indices explicity. The description with Mackey states follows the pattern of the description in the well-known papers of Jacob and Wick and of Trueman and Wick and covers in particular partial-wave analyses, discrete symmetries and crossing. The usefulness and elegance of the Mackey states become evident in the course of the discussion. (auth)

8471 CROSSED-CHANNEL UNITARITY CONSTRAINT ON REGGE-CUT AMPLITUDES. Guerin, F. (Univ., Nice). Nucl. Phys.; B49: 557-72(1972).

The conventional cut models violate elastic unitarity in the crossed channel. It is shown that the remedy is simple and unique, at least for Regge–Regge cuts. The fulfillment of the unitary constraint leads to a substantial modification of the strength of the cut, but hardly modifies the t-dependence, the phase, or the spin dependence of the Regge-cut amplitude. The absorption correction depends on one parameter whose effect is to modify the conventional strength of the absorption by a factor ranging from 0.1 to 1.6. (auth)

PHYSICS (LOW-TEMPERATURE)

8472 REVIEW OF SUPERFLUIDS AND SUPERCONDUCTORS. Martin, P. C. (Havard Univ., Cambridge, Mass.). pp 175-99 of Statistical Mechanics at the Turn of the Decade. /Cohen, E. G. D. (ed.). New York; Marcel Dekker, Inc. (1971).

From Symposium on statistical mechanics at the turn of the decade; Evanston, IL. (28 Oct 1969). See CONF-691071.

A summary is given of the basis for describing the thermodynamic and hydrodynamics of the superfluid. A brief resumé is given of the nonequilibrium problems associated with vortex motion, supercurrent decay, and fluctuations. No references. (D.L.C.)

Superfluidity

8473 (CONF-720833-10) NEUTRON SCATTERING INVESTIGATION OF BOSE–EINSTEIN CONDENSATION IN SUPERFLUID ^{4}He. Mook, H. A.; Scherm, R.; Wilkinson, M. K. (Oak Ridge National Lab., Tenn.). Aug 1972. 8p. Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Measurements were made on a triple-axis spectrometer at a constant scattering angle of 135° and a momentum transfer of 14.33 $Å^{-1}$. The results of the measurements are shown for ^{4}He at 1.2°K and 4.2°K. The data were all normalized to one run which represents about 20 minutes counting time per point. (M.H.R.)

8474 VORTICITY AT A GRID IN LIQUID He II. Doake, C. S. M.; Gribbon, P. W. F. (Univ. of St. Andrews, Fife, Scotland). J. Phys., C (London); 5: No. 21, 2998-3011(31 Oct 1972).

The current transmitted by a grid in an ion cell was studied as a function of electric field, temperature, and pressure in He II. The current at low fields was found to vary in a way similar to that expected for a grid in classical liquids. However, at fields beyond those necessary for the nucleation of vortex rings by the ions, the current increased and reached a maximum value. A detailed study of the maximum current suggested that it originated from the effect of some kind of vorticity that had been captured or become closely linked with the grid mesh structure: a larger current was transmitted when some ions were trapped on the vorticity so that a repulsive space charge Coulomb field was established close to the grid and diverted a larger fraction of the ions through the apertures of the grid. A comparison between these observations and those of Bruschi et al. (Phys. Rev., 143: 84-90 (1966)) on second sound attenuation by the ions transmitted through a grid at similar fields indicated that the vorticity might have a common origin at the grid in both experiments. (auth)

8475 SEARCH FOR THE ac JOSEPHSON EFFECT IN LIQUID HELIUM. Musinski, D. L.; Douglass, D. H. (Univ. of Rochester, NY). Phys. Rev. Lett.; 29: No. 23, 1541-4(4 Dec 1972).

In the presence of an ac sound field, stable states of zero flow between two baths of liquid helium connected by a small orifice were found which are believed to be the same as those which had been previously identified as the ac Josephson effect. It is shown that these states are not Josephson states. (auth)

8476 ISOTHERMAL FLOW OF HELIUM II THROUGH PLANE SLITS. Lauter, H. J.; Keck, K. (Johannes Gutenberg Univ., Mainz). Z. Phys.; 256: No. 4, 323-31(1972).

Measurements are reported on the isothermal, gravitational flow of liquid He II through narrow plane slits. The employed superleak consists of ring-shaped Hostaphan foils packed in layers. The distance between the foils is varied by pressure. The performance of the measurements and the observance of the isothermal conditions are described. The velocity of the superfluid component of He II is calculated in dependence on the width of the slits, temperature, and hydrostatic pressure. Especially the critical velocity is considered. (auth)

8477 DIELECTRIC BREAKDOWN OF HELIUM AT LOW TEMPERATURES. Gerhold, J. (Anstalt fuer Tieftemperaturforschung, Graz). Cryogenics; 12: No. 5, 370-6(Oct 1972).

Helium is of particular interest as a basic insulating agent in the development of superconducting electrical power equipment. Contrary to the low electrical breakdown strength under ordinary conditions, helium shows satisfactory breakdown strength at very low temperatures where its density is high. The breakdown strength of helium in suitable states is superior to that of good transformer oil. It is shown that, in agreement with breakdown theories of gases, the breakdown strength of gaseous helium is determined mainly by the gas density. On the other hand, the breakdown strength of liquid helium at pressures above 1 bar is determined mainly by the helium pressure. The phenomenon may be explained by the formation of gas bubbles produced by moving ions in the liquid leading to electrical breakdown. (auth)

8478 COHERENT MATTER FIELD PHENOMENA IN SUPERFLUIDS. Anderson, P. W. (Bell Telephone Labs., Inc., Murray Hill, NJ). pp 21-40 of Belfer Graduate School of Science Annual Science Conference Proceedings. Vol. 2. /Gelbart, A. (ed.). New York; Marcel Dekker, Inc. (1969).

The mean value of the quantum-particle field is dealt with as though it were one of the macroscopic thermodynamic and dynamical variables of the system, just as in, say, elasticity of crystals, in which the position of a particular part of the crystal is dealt with as a macroscopic thermodynamical variable, or in ferromagnetism, in which the magnetization is dealt with as a macroscopic variable. Both are variables that destroy symmetry principles, but are well known by daily experience to be usable as thermodynamic variables. It is possible to define the variable not only for the total system but also for individual pieces of the system, small cells macroscopic from the atomic point of view but microscopic from the point of view presented. One can deal with coarse-grained averages as well as with macroscopic averages. (21 references) (J.C.W.)

Superconductivity

Refer also to abstracts 8501, 8502, and 8897.

8479 (CEA-N-1552) MAGNETIC INSTABILITIES IN HARD SUPERCONDUCTORS OF THE SECOND KIND AND THEIR CONSEQUENCES. Rappanello, Daniel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1972. 248p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

It is shown that magnetic instabilities in Type-II superconductors may be detected from measurements of the admissible currents in the material. Such currents were measured and calculations on instabilities were made. Stability criteria associated with the optimum performance of superconducting filaments were established for different magnetic conditions. A preliminary interpretation of the training phenomenon is given. (auth)

8480 (COO-3169-11) FLUX MOTION AND PINNING IN A TYPE II SUPERCONDUCTOR. Putz, A. G. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Aug 1972. Contract AT(30-1)-4060. 123p. Dep. NTIS.

Thesis.

Earlier experimental results on degradation and recovery of the lattice in deformed niobium crystals are investigated. Voltage–current hysteresis curves when the current is swept up and down are compared. The results are discussed in terms of a theoretical model. (M.O.W.)

8481 (COO-3169-13) SCALING LAWS FOR FLUX PINNING IN HARD SUPERCONDUCTORS. Kramer, E. J. (Cornell Univ., Ithaca, N. Y. Materials Science Center). 1972. 41p. Dep. NTIS.

For all hard, high-field superconductors examined to date, there is a maximum in the pinning force density F_p as a function of the reduced magnetic field h. Fietz and Webb first demonstrated in dilute Nb alloys that the peak in F_p scales as $[H_{c_2}(T)]^{2.5}$ if the temperature is changed; the maximum value of F_p occurred at the same value of reduced field regardless of temperature. Recent data on the temperature dependence of pinning in Nb_3Sn, Nb–25% Zr and a Nb–Ti alloy, which exhibits the "peak effect," are analyzed to show that similar scaling laws are obeyed by these materials. All presently available evidence indicates, however, that the reduced field h_p at which the maximum F_p occurs, as well as the height and shape of this maximum, can be altered by metallurgical treatment. Apparently weak pinning defects, or widely spaced ones, produce a small peak in $F_p(h)$ at high h whereas strong, closely spaced pins produce a large peak in $F_p(h)$ at low h without producing much change in $F_p(h)$ at high h. A model which predicts these metallurgical effects, as well as the scaling laws, is proposed. According to the model at $h \ll h_p$, flux motion occurs primarily by unpinning of line pins, whereas at $h \gg h_p$ it occurs by synchronous shear of the flux line lattice around line pins too strong to be broken. In the high-field regime, where

quantitative predictions are possible, the magnitude and field dependence of F_p are in good agreement with experiment. In this model the anomalous "peak effect" occurs whenever line pins are relatively weak, producing a narrow peak in $F_p(h)$ at high h. (auth)

8482 (COO-3169-14) EFFECT OF FLUX LINE LATTICE HISTORY ON THE CRITICAL CURRENT IN NIOBIUM. Steingart, Marvin; Putz, A. G.; Kramer, E. J. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 1972. 25p. Dep. NTIS.

The critical current in a plastically deformed Nb single crystal was shown to vary with the method of formation of the flux line lattice (FLL). The largest critical currents were observed when the FLL was formed by cooling the sample from above $T_c(H)$. Passing a current through the sample during the cooling process, in the same direction as it was subsequently swept, increased I_c by up to 60%. Decreases in I_c, with the V–I characteristic asymptotically approaching the characteristic after-flux flow could be induced by slowly cycling the current at zero voltage (fatigue effect). The size of the decrease was found to be dependent on the number of cycles and, especially for negative current excursions, on the amplitude of these excursions. A model is proposed to account for these observations. Optimum pinning of the FLL to the underlying pin structure occurs in the model at the moment the FLL is formed. Changes in the local value of the FLL parameter, through changes in B or changes in FLL defect structure, are thought to decrease the number of pins interacting with the FLL, and hence to decrease the critical current. (auth)

8483 SUPERCONDUCTIVITY MECHANISMS AND COVALENT INSTABILITIES. Phillips, J. C. (Bell Telephone Labs., Murray Hill, NJ). Phys. Rev. Lett.; 29: No. 23, 1551-4 (4 Dec 1972).

Quantitative estimates are made of the maximum value of the superconductive transition temperature T_c attainable through combining electron–exciton interactions with electron–phonon interactions in metal–semiconductor sandwiches. Because of covalent instabilities, it is argued that no enhancement of T_c can be expected if the initial value of T_c in the pure metal was greater than 5°K. (auth)

8484 CRITICAL TEMPERATURE IN SUPERCONDUCTIVITY OF TRANSITION METALS OF THE YTTRIUM–PALLADIUM SERIES. Korsunskii, M. I.; Genkin, Ya. E.; Zavodinskii, V. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Dokl. Akad. Nauk SSSR; 204: No. 5, 1081-3(11 Jun 1972). (In Russian).

The electron–phonon interaction parameter, λ, is related to the critical temperature of superconductivity as shown by an equation by W. L. McMillan (1968). Values of λ were theoretically calculated for Zr, Nb, Mo, and Ru as functions of the number of collectivized electrons, n. The quantity λ passed through a maximum at $n \sim 0.25$. The results were in good agreement with the experimental values. (K.S.W.)

8485 THEORY OF MAGNETIC IMPURITIES IN SUPERCONDUCTORS. IV. THERMODYNAMIC PROPERTIES NEAR T_c. Mueller-Hartmann, E. (Institut fuer Festkoerperforschung, Juelich, Ger); Zittartz, J. Z. Phys.; 256: No. 4, 366-79(1972).

The jump of the specific heat at the transition temperature is calculated for a superconductor with magnetic impurities. The calculation includes the Kondo effect and is exact within the Nagaoka approximation. (auth)

8486 INTERMEDIATE STATE IN THIN LEAD AND TIN SPECIMENS. Bodmer, A.; Essmann, U.; Traeuble, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Status Solidi (a); 13: No. 2, 471-81(16 Oct 1972).

The magnetic structure of the intermediate state in thin superconducting tin and lead foils in perpendicular magnetic fields is made visible by decoration with small iron particles. The dependence on magnetic history and thickness is compared with current theories. In lead, and much more so in tin, the orientation of the domains is related to that of the crystal lattice. In very perfect specimens, triangular lattices of macro-flux lines are observed. (24 references) (auth)

8487 CALCULATION OF RF-INDUCED CURRENT–VOLTAGE CHARACTERISTICS OF A MEASURED JOSEPHSON TUNNEL JUNCTION. Hahlbohm, H. D.; Hoffmann, A.; Luebbig, H.; Luther, H.; Seeck, S. (Physikalisch-Technische Bundesanstalt, Berlin). Phys. Status Solidi (a); 13: No. 2, 607-12(16 Oct 1972).

The rf-induced current–voltage characteristics of a small Josephson tunnel junction are calculated for various values of rf power. The contact parameters (capacity, maximum of the zero-voltage pair-tunneling current, and nonlinear quasi-particle characteristic) are correlated to measured values of a Sn–SnO–Sn junction near the transition temperature. (auth)

8488 THERMAL EFFECT IN VOLTAGE–CURRENT CHARACTERISTICS OF LARGE JOSEPHSON JUNCTIONS. Barone, A. (Univ. of Wisconsin, Madison). Phys. Status Solidi (a); 13: No. 2, K93-5(16 Oct 1972).

Rounded voltage–current characteristics were observed in Pb/Pb oxide/Pb and Sn/Sn oxide/Sn large Josephson junctions at helium bath temperatures far below T_c. It is suggested that the rounding effect could be caused by local heating produced by power dissipation due to flux on motion in the junction. (D.L.C.)

8489 ONSET OF SUPERCONDUCTIVITY IN SODIUM AND POTASSIUM INTERCALATED MOLYBDENUM DISULPHIDE. Somoano, R. B.; Rembaum, A. JPL Quart. Tech. Rev.; 1: No. 3, 33-7(Oct 1971).

Molybdenum disulfide in the form of natural crystals or powder was intercalated at −65 to −70°C with sodium and potassium, using the liquid ammonia technique. All intercalated samples were found to show a superconducting transition. A plot of the percent of diamagnetic throw versus temperature indicates the possible existence of two phases in the potassium-intercalated molybdenum disulfide. The onset of superconductivity in potassium- and sodium-intercalated molybdenite powder was found to be ≅6.2 and ≅4.5 K, respectively. The observed superconductivity is believed to be due to an increase in electron density as a result of intercalation. (auth)

8490 COEXISTENCE OF ANTIFERROMAGNETISM AND SUPERCONDUCTIVITY IN THE Cr–Re SYSTEM. Butylenko, A. K.; Suprunenko, P. A.; Kal'naya, G. I. (Inst. of Metal Physics, Kiev). Metallofizika; No. 40, 61-4(1972). (In Russian).

Experimental and literature data on changes in the physical properties in the solid solution region of Re–Cr system were compared. An alloy transformation from the antiferromagnetic state to the superconducting state was found to be dependent on concentration. The supposition is made that this transition may be associated with ordering processes in the alloys with the formation of a superconducting phase of the β-W(CrO_3) type, and related to the morphology of similar systems: Mo–Re, W–Re, and others. (tr-auth)

8491 NONLINEARITY MECHANISM OF THE VOLT–AMPERE CHARACTERISTICS OF POINT JUNCTIONS. Bogatina, N. I.; Yanson, I. K. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1312-20(Oct 1972). (In Russian).

Local breakdown of an oxide layer results in a short circuit of the film tunnel junctions. Consequently, a narrow conducting bridge between the two metal films is formed, which is a variety of a point junction. Nonlinearity of the volt–ampere characteristics of such junctions is observed at voltages between 0 and 100 mV and temperatures above T_c of the superconducting transition. The nonlinearity remains up to liquid-nitrogen temperatures. The cause of the nonlinearity is that the mean free path of electrons accelerated up to a voltage of V significantly depends on the magnitude of the voltage if $eV > kT$ and $eV > k\Theta_D$. In this case, the electrons are rapidly slowed down when the drift velocity reaches that of sound in the metal. (auth)

8492 FIELD ION MICROSCOPIC STUDY OF THE MICROSTRUCTURE OF SUPERCONDUCTING DEFORMABLE NIOBIUM ALLOYS. Garber, R. I.; Lazarev, B. G.; Lazareva, L. S.; Mikhailovskii, I. M.; Sidorenko, N. N. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1359-62(Oct 1972). (In Russian).

The structure of the Nb–Ti (60 at. % Ti) is studied with a resolution of less than 3 Å after cold deformation and various thermal treatments. The presence of a developed system of highly dispersed filamentous zones enriched in niobium is established. In an alloy subjected to cold deformation the transverse dimensions of the zones are ~10 Å, the depth is over 10^3 lattice constants. During thermal treatment the filamentous zones form plaits with cross sections of (3 to 5) × 10^2 Å. A structure containing 20- to 50-Å filaments corresponds to treated material with maximum critical parameters. The results confirm the assumption previously suggested that the high current-carrying properties of the alloy are due to layers of niobium or of a phase with a composition close to that of niobium, these precipitating as a result of thermal treatment and forming a space lattice. (auth)

8493 TEMPERATURE DEPENDENCE OF THE VISCOSITY COEFFICIENT IN TYPE II SUPERCONDUCTORS. Fogel, N. Ya. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1371-80(Oct 1972). (In Russian).

The flux flow resistance ρ_f of 76 at. % Pb and 24 at. % In alloy samples is measured in a broad range of temperature T and magnetic field strengths H. It is shown that the empirical laws formulated by Kim do not hold. Treatment of the experimental results by making use of the variable $H/H_{c2}(t)$ revealed some new regular-

ities in the behavior of the differential resistance of superconductors of the second kind. The dependence of ρ_f/ρ_n on $H/H_{c2}(t)$ is linear up to a field strength of 0.5 $H_{c2}(t)$ at all temperatures. The dependence of the viscosity coefficient η on temperature is determined from the slope of the straight lines. The magnitude of η and its dependence on temperature are interpreted by taking into account dissipation related to normal currents and dissipation due to the finite relaxation time for the order parameter to reach its equilibrium value. The experimental values of η are in good agreement with the minimal value of the viscosity coefficient determined on basis of microscopic theory. (auth)

8494 SUPERCONDUCTIVITY OF NIOBIUM–ALUMINUM–SILICON ALLOYS. Pan, V. M.; Latysheva, V. I.; Sudovtsov, A. I. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 33: No. 6, 1311-13(Jun 1972). (In Russian).

The isothermal cross section (at 1,700°C) of the ternary phase composition diagram was constructed for the system Al–Nb–Si up to 30 at. % Al and Si. The existence of Nb_3Al, Nb_2Al, and α, β, γ, and σ phases and mixtures of these are discussed. Curves of the superconducting transition of a number of such ternary compositions were drawn. (K.S.W.)

8495 CHARACTERISTICS OF SUPERCONDUCTING ALLOYS OF NIOBIUM–TIN PREPARED BY VACUUM EVAPORATION. Golovashkin, A. I.; Levchenko, I. S.; Motulevich, G. P. (Lebedev Inst. of Physics, Moscow). Fiz. Metal. Metalloved.; 33: No. 6, 1213-21(Jun 1972). (In Russian).

A series of 24 Nb–Sn compositions containing from 4 to 67 at. % Sn were prepared by evaporation in a vacuum and subsequent annealing of the deposited material. Their superconducting characteristics were investigated, and the concentration dependence of the density and the conductivities were measured. The temperature dependence of the conductivity had an exponential member, and a peculiarity at $T \sim 30°K$ was noted. Electron–phonon interaction constants were determined, and the depth of penetration of a low-frequency field was evaluated. (tr-auth)

Equipment and Devices

Refer also to abstract 7961.

8496 (JPRS–57638) SUPERCONDUCTING MAGNET SYSTEMS, FIELD WINDINGS, AND INDUCTORS. Sychev, V. V.; Borzov, G. G.; Bertinov, A. I. Translated from Izv. Akad. Nauk SSSR, Energ. Transp.; No. 4, 21-38; 39-49(1972). 37p. NTIS.

The report contains articles on some problems of building superconducting magnet systems, problems of building high-power turbogenerator with superconducting field windings and on the selection of basic dimensions of synchronous generator with superconducting inductor. (auth)

8497 (SLAC-PUB-963) POWER LOSSES IN RF SUPERCONDUCTING CAVITIES. Rabinowitz, Mario (Stanford Linear Accelerator Center, Calif.). Sep 1972. 7p. (CONF-701111–4). Dep. NTIS.

From Electron and Atomic Physics Division meeting; Seattle, WA, (23 Nov 1970).

Power losses in microwave superconducting cavities are not well understood at very low temperatures and/or at very high field levels. Established theories of superconducting surface resistance do not work in these ranges. It is proposed that the discrepancy lies in the presence of nonsuperconducting power loss mechanisms. Various mechanisms are considered, such as dielectric loss due to surface contamination by oxides and adsorbed gas; field emission; normal regions; fluxoids; etc. Cavity Q ($\sim 10^{11}$) is extremely sensitive to impurities and lattice defects on and near the surface. An oscillating fluxoid is most likely responsible for critical power loss at high field levels, and small stationary normal regions for residual power loss at low temperature. (auth)

8498 SUPERCONDUCTING ELECTRICAL MACHINES. Mulhall, B. E. (International Research and Development Co. Ltd., Fossway, Eng.). Rev. Phys. Technol.; 3: No. 2, 108-29 (1972).

The properties of modern superconducting materials and their application in windings producing intense magnetic fields are outlined. The use of superconductors in electrical machines is discussed generally and developments reviewed. The two principal lines of development, dc homopolar and ac heteropolar machines with superconducting field windings are described in detail. (auth)

8499 IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTING CABLES. Taylor, M. T.; Sutton, J. (to Central Electricity Generating Board). British Patent 1,285,441. 16 Aug 1972. Filed 9 May 1968.

Reference is made to superconducting power cables of improved construction for carrying large alternating currents. Present designs rely on Nb layers for carrying the normal operating current, but its use places restrictions on the size and operating temperature of the cable, and furthermore the Nb is of no use for carrying fault currents. An alternative approach is to use a hard type-II superconductor for carrying the normal operating current and which would also serve for carrying fault current, but this is limited by the ac losses in hard type-II superconductors. The present specification is concerned with the provision of a form of type-II superconducting material permitting considerably higher current densities than with present commercially available materials, thus reducing the heat produced during normal operation and fault conditions. The superconducting material is formed of thin (0.01 to 0.5 μ) continuous layers of a type-II superconductor separated by layers of dielectric or highly resistive material. The type-II superconductor may be Nb alloy and the dielectric material may be SiO or an oxide of Nb. The cable may be comprised of two concentric tubes of Cu or Al, with the superconducting material arranged on the outer surface of the inner tube and the inner surface of the outer tube. A laminar structure may also be employed for the superconducting material using type-II superconductors of different transition temperatures. The materials in this case can be Nb and Nb–Ta alloy, or NbN and Nb. (UK)

8500 IMPROVEMENTS IN OR RELATING TO ELECTRICAL CONDUCTORS USING SUPERCONDUCTING MATERIAL. Taylor, M. T.; Sutton, J. (to Central Electricity Generating Board). British Patent 1,285,442. 16 Aug 1972. Filed 11 Aug 1969.

The present specification is concerned with the provision of superconducting material of laminar structure for use in cables. This consists of thin continuous layers of a type-II superconductor separated by layers of a second material that is superconducting at a lower transition temperature. The conductor is operated at a temperature just below the transition temperature of the second material. The laminated superconducting material, at the operating temperature, has a positive rate of change of critical current density with temperature or, for the same critical current density, less negative than the first type-II superconducting material. The cable may comprise two concentric tubes of Cu or Al with the superconducting material on the outer surface of the inner tube and the inner surface of the outer tube. Instead of using a single second superconducting material, two or more materials may be used, in layers, these materials all having different transition temperatures less than that of the first material. The laminate may have an outer Nb coating, or an outer coating of layers of type-II superconductor separated by layers of dielectric or resistive material. The first superconducting material may be Nb and the second a Nb–Ta alloy, or alternatively NbN and Nb. (UK)

8501 STATE-OF-THE-ART OF SUPERCONDUCTING MAGNETS. Lubell, M. S. (Oak Ridge National Lab., TN). Cryogenics; 12: No. 5, 340-55(Oct 1972).

A survey of the most recent developments in superconducting magnet materials is presented, and complete data on the upper critical field and transition temperature for the Nb–Ti alloy system are given. The overall critical current density of compound conductors is shown for both low and high field commercial superconductors. A tabulation is given of high field and large bore solenoids, comparing design and test data. Comparative data are also given for some nonsolenoidal coils, and details are listed for the systems under construction or design. A criterion is derived for the stable current density attainable in extremely large magnet systems such as those envisioned for fusion reactors. The review concludes with summaries concerning the structural materials useful in large magnets and the effects of radiation on superconducting magnets. (auth)

8502 SUPERCONDUCTING MATERIALS. A SURVEY. Battams, P. A. Cryogenics; 12: No. 5, 356-61(Oct 1972).

A survey is presented of the types of material available, late in 1971, from the major producers of superconducting materials throughout the world, and the operating performance expected from such material. The information is supplied under headings: type of material, ratio superconductor/stabilizer, range of diameters available, number of filaments available, highest operating temperature, highest operating field, and price; and further details for specific materials, such as critical current and current density for various values of field, price, special advantages, applications. (UK)

8503 TERMINAL CHARACTERISTICS AND THERMAL STABILITY OF COMPOSITE SUPERCONDUCTING MATERIALS. PART 1. Sytchev, V. V.; Zenkevitch, V. B.; Altov, V. A.; Kremlev, M. G.; Kulysov, N. A. (Inst. of High Temperature, Moscow). Cryogenics; 12: No. 5, 377-84(Oct 1972).

By investigating static volt ampere characteristics of a composite (normal + superconducting) material, many interesting features

of thermal environments in the liquid helium coolant can be revealed. A description is given of experiments to reproduce terminal characteristics of a small piece of the conductor, placed in isothermal conditions and, in particular, to observe otherwise unstable portions of characteristics with the negative slope. Different aspects of the problem of cryostatic stabilization are discussed, paying particular attention to the influence of boiling transition in liquid helium and to the temperature variation of resistivity of the normal stabilizer on the safety of the conductor. (auth)

8504 BEHAVIOR OF A MULTIPLE-QUANTUM-STATE SUPERCONDUCTING RING WITH JOSEPHSON TUNNEL JUNCTIONS. Wilson, J.; Gayley, R. I. (State Univ. of New York, Buffalo). Solid State Commun.; 11: No. 9, 1183-5(1 Nov 1972).

A way has been found to preselect the quantum state of a superconducting ring that has a number of possible states, and the limits of stability of these states have been studied. It is found that when these limits are exceeded, two different kinds of transitions can occur. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 8888 and 8925.

8505 (JINR-P4-6681) INTERACTION OF ULTRACOLD NEUTRONS WITH THERMAL VIBRATIONS OF REFLECTING MEDIA. **Ignatovich, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).**

Inelastic interaction of ultracold neutrons (UCN) with media is considered. The probability of UCN heating at single collision with the wall is considered in a single-phonon approximation. The contribution of the surface thermal vibrations to the above-mentioned probability is estimated. It is shown that decrease of the coherent scattering amplitude, which is due to the Debye–Waller factor, does not lead to the decrease of the UCN mirror reflection coefficient. (auth)

8506 (ORNL-TM-3944) NEUTRON CROSS-SECTION SENSITIVITY ANALYSIS: A GENERAL APPROACH ILLUSTRATED FOR A Na–Fe SYSTEM. **Bartine, D. E.; Oblow, E.; Mynatt, F. R. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 29p. Dep. NTIS.**

A general approach to sensitivity studies is introduced using a quantitative definition of cross-section sensitivity. The definition offered is intended to be both practical and physically meaningful. Its advantages in comparison with other approaches are discussed and its use in analysis is illustrated for a sodium–iron transport problem. Results of the analysis include a discussion of the role of important total cross-section minima in deep penetration in sodium and iron and the importance of certain energy ranges and partial cross sections for the sodium–iron system. The predictive aspect of the approach is demonstrated in comparisons of rigorous and predicted results for small cross-section perturbations and in conclusions about the order of Legendre expansion of the scattering kernel. (auth)

8507 (PTHM-FRM-101) CORRECTIONS FOR THE DERIVATION OF SCATTERING LENGTHS FROM NEUTRON TOTAL CROSS SECTION MEASUREMENTS. EXAMPLE: NEUTRON–ELECTRON SCATTERING. **Binder, K. (Technische Universitaet, Munich (West Germany)). Apr 1970. 25p. (In German). INIS.**

Various corrections have to be considered for the derivation of the scattering lengths of nuclei and electrons, respectively, from the precise measurement of total cross sections. The total cross section for the Schwinger scattering is calculated, and the order of magnitude of the magnetic scattering from diamagnetic substances is estimated. Correction terms are discussed which have to be added to the Fermi potential in a second order treatment. It is shown that the neutron scattering from conduction electrons can be neglected. Expressions are derived for the double-Bragg scattering of neutrons from polycrystals. (GF)

8508 PRODUCTION OF MONOENERGETIC NEUTRONS BY RESONANCE DOUBLE-SCATTERING. **Mlitzke, E. (Physikalisch-Technische Bundesanstalt, Brunswick). Atomkernenergie; 19: No. 4, 317-24(Jul 1972). (In German).**

For producing a beam of quasimonoenergetic neutrons around 2.3 keV, an experimental arrangement is proposed consisting of a sodium scatterer (resonance energy 2.85 keV) positioned in the center of an experimental channel penetrating the reactor core and a manganese scatterer (resonance energy 2.375 keV) outside the reactor. The calculated energy distribution is compared with that of the scattering from two sodium discs. In the latter case no resonance double-scattering occurs due to the energy loss in the first scatterer. This energy loss, which depends on scattering angle, is such that these neutrons can be double-scattered very effectively by the scattering resonance of manganese whereas background scattering is strongly reduced. Resonance double-scattering is therefore superior to other methods of resonance scattering known up to this time. (auth)

8509 NEUTRON FLUX PERTURBATIONS DUE TO INFINITE PLANE ABSORBERS. 3. COSINE FLUX. **Morsy, S.; Williams, M. M. R. (Queen Mary Coll., London). J. Phys., D (London); 5: No. 11, 1993-2014(Nov 1972).**

This work was conducted with the aim of gaining some insight into the problem of neutron flux pertubations due to absorbing materials placed in a flux gradient. A hybrid theory is developed, which combines the advantage of the conventional asymptotic reactor theory approximation with the virtues of an exact solution by the Wiener-Hopf technique. The theory is able to provide information about the effect of neutron leakage on the angular distribution at the surface of a purely absorbing foil or control plate embedded in a finite moderator in which the unperturbed shape is a cosine function. Single and multivelocity calculations of the angular distribution at the surface of the absorber, the flux distortion factor, the flux depression factor and the self-shielding factor have been carried out. The effect of flux distortion on the locus of the depression in a single foil as it is moved across the system is shown to be very small indeed, and one can confidently neglect this effect when calculating errors in buckling measurements by foil activation. However, the effect of flux curvature on foil activation in cells requires further examination if such experiments are to be interpreted with confidence. (auth)

8510 NEUTRON SPECTRUM FROM A FISSION SOURCE IN WATER. **Profio, A. E. (Univ. of California, Santa Barbara); Cerbone, R. J.; Huffman, D. L. Nucl. Sci. Eng.; 49: No. 2, 232-6 (Oct 1972).**

Time-of-flight measurements of the neutron angular flux spectrum in water have been made to provide a standard of comparison for neutron penetration calculations. The spectrum from 0.002 eV to 12 MeV was measured with an accuracy of ±10 to ±30% and a resolution of 5 to 15%, at angles from 0 to 90 deg and penetrations to 38 cm. Comparisons with discrete ordinates calculations using ENDF/B and GAM-II cross sections indicate fairly good agreement. (auth)

8511 FAST NEUTRON POLARISATION. **Galloway, R. B. (Univ. of Edinburgh). Proc. Roy. Soc. Edinburgh, Sect. A; 70: 181-90(1972).**

The state of knowledge of fast neutron polarization due to elastic scattering is reviewed in relation to the optical model of the process. There is clearly a substantial lack of polarization data at neutron energies and concerning nuclei appropriate to the optical model description. The situation for the extremes of small and of large angle scattering is also considered. (auth)

8512 APPLICATION OF THE GREULING–GOERTZEL APPROXIMATION TO THE COLLISION PROBABILITY METHOD IN HETEROGENEOUS CELL SYSTEMS. **Takeda, T.; Sekiya, T. (Osaka Univ.). Energ. Nucl. (Milan); 19: No. 11, 684-8(Nov 1972).**

This note describes an application of the Greuling–Goertzel approximation to the first-flight collision probability method in heterogeneous cell systems: the spatial coupling between regions is expressed in matrix form, which allows an analytical solution to be obtained. (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 8293, 8295, 8338, 8408, 8541, 8542, 8546, 8548, 8549, 8551, 8555, 8556, and 8721.

8513 (LA-5051) CROSS SECTIONS AND ANALYZING POWERS IN DEUTERON ELASTIC SCATTERING. **Hardekopf, R. A.; Armstrong, D. D.; Catlin, L. L.; Keaton, P. W. Jr.; Lawrence, G. P. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 7p. Dep. NTIS.**

All tensor analyzing powers have been measured for 15-MeV deuterons elastically scattered from ^{4}He, ^{52}Cr, ^{56}Fe, ^{60}Ni, ^{90}Zr, ^{122}Sn, and ^{197}Au. The results are presented in tabular and graphical form along with relative cross sections obtained for all but ^{4}He. (auth)

8514 (LA-5083) CROSS SECTIONS FOR P + NUCLEUS → $\pi^{\pm}$ + ... FOR 740-MeV PROTONS. **Cochran, D. R. F.; Dean, P. N.; Gram, P. A. M.; Knapp, E. A.; Martin, E. R.; Nagle, D. E.; Perkins, R. B.; Shlaer, W. J.; Thiessen, H. A.; Theriot, E. D. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 29p. Dep. NTIS.**

Cross sections for $\pi^{\pm}$ production by 740-MeV protons on various nuclei [H, D, Be, C, Al, Ti, Cu, Ag, Ta, Pb, Th] are presented. (auth)

8515 MEASUREMENT OF THE ABSORPTION CROSS SECTION OF FAST DEUTERONS IN NUCLEAR EMULSION. **Kozuchova, S. (Inst. of Experimental Physics, Kosice, Czech.); Tucek, J. Fyz. Cas.; 21: No. 4, 221-7(1971). (In Slovak).**

A study is presented aimed at determining the mean free path of deuterons with momentum of 2.45 GeV/c in nuclear emulsion, and

thus the absorption cross section of interactions between the deuterons and atomic nuclei in the emulsion. Attention was paid to the determination of the relative amount of impurities in the primary deuteron beam. The amount of impurities was found to range from 2.5% at the axis to 13% at the periphery of the beam. The impurities consisted of π^+ mesons and of protons, equally represented. After corrections, and without (0 + 0) and (0 + 1) interactions for the angles of the secondary tracks smaller than 2.5°, the mean free path was determined as $\langle l_d \rangle = 21.5 \pm 2.2$ cm. (NSA of Czech)

8516 FINAL-STATE INTERACTIONS AND A COMPARISON OF THE ^{3}H(p,pp)nn AND ^{3}He(p,pp)pn REACTIONS. Fritts, M. J.; Parker, P. D. (Yale Univ., New Haven). Nucl. Phys.; A198: No. 1, 109-28(1972).

The ^{3}He(p,pp)pn and ^{3}H(p,pp)nn reactions have been studied at an incident proton energy of 20 MeV under identical kinematic conditions. A Monte Carlo simulation technique was employed to generate predictions from the Watson–Migdal theory of final-state interactions which included all experimental and data reduction effects. The ^{3}He(p,pp)pn data are well described by the Watson–Migdal formalism for the p-n final-state interaction both on and off the spectator angles, showing no evidence of an important contribution due to quasi-free scattering. For the tritium data, however, without the inclusion of quasi-free scattering effects a fit could be found only for unrealistically large scattering lengths. The addition of a quasi-free scattering contribution improved the fits, but still did not adequately describe the data. A possible explanation for the discrepancy is discussed. (auth)

8517 SHELL-MODEL STUDY OF ^{4}He WITH REALISTIC FORCES. Szydlik, P. P. (State University Coll., Plattsburgh, N. Y.); Borysowicz, J. R.; Wagner, R. F. Phys. Rev., C.; 6: No. 5, 1902-5(Nov 1972).

A shell-model study of the A = 4 system previously performed with purely central forces was repeated using both the Tabakin and Sussex interactions. Agreement with the experimental spectrum improved. Some shift of the E1 strength to the lower of the 1^-, T = 1 levels occurred, but the bulk of the strength remained in the state at higher energy. Overall results achieved with the Sussex interaction were comparable to those obtained using the Tabakin potential. (1 figure, 2 tables) (auth)

8518 ANGULAR DISTRIBUTIONS AND ABSOLUTE CROSS SECTIONS FOR THE T(p,n)^{3}He NEUTRON SOURCE REACTION. McDaniels, D. K.; Drosg, M.; Hopkins, J. C.; Seagrave, J. D. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C.; 6: No. 5, 1593-1600(Nov 1972).

The T(p,n)^{3}He neutron source reaction was reinvestigated by utilizing the time-of-flight technique. This study was motivated by the lack of cross-section data above 13 MeV, by large uncertainties in the zero-degree absolute cross sections, and by the need to improve the accuracy of both the absolute and relative cross-section data. Angular distributions were measured from 0° to 140° at proton energies of 6, 7, 10, 11, 12, 13, 14, 15, and 16 MeV with a neutron detector whose relative efficiency was established to ±1.5%. Absolute cross sections at zero degrees were obtained by normalization of the zero-degree yields measured with the neutron detector to precise charged-particle cross sections obtained for the reaction T(p,^{3}He)n. These results were compared to data obtained with a proton-recoil counter telescope. (8 figures, 5 tables) (auth)

8519 VARIATION IN TRINUCLEON BOUND-STATE PROPERTIES WITH PHASE-EQUIVALENT NUCLEON–NUCLEON INTERACTIONS. Harper, E. P.; Kim, Y. E.; Tubis, A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C.; 6: No. 5, 1601-8(Nov 1972).

The Faddeev formalism is used to investigate the variation of the trinucleon binding energy and electromagnetic form factors with phase-equivalent transformations of the Reid soft-core potential. The transformed nucleon–nucleon interactions used in the calculations are the same as, or slight variations of, those considered by Haftel and Tabakin in studies of nuclear matter. The corresponding transformed two-nucleon wave functions are essentially unchanged for nucleon separations greater than 1 fm. The variation of the trinucleon binding energy follows the same trend as (but is generally much smaller than) the corresponding variation of E_B/A for nuclear matter. The largest increase in E_B(trinucleon) is 0.19 MeV, which gives E_B(total) ≈ 6.9 MeV. The position of the minimum of the calculated $|F_{ch}^{^3He}(Q^2)|$ (experimental value: $Q^2 \approx 11.8^{-2}$) varies between $Q^2 = 14.4$ and 18 fm^{-2}. (4 figures, 2 tables) (auth)

8520 NONLOCAL SEPARABLE POTENTIAL FOR $\alpha-\alpha$ INTERACTION. Meboniya, D. V.; Surmava, I. G. (Tbilisi State Univ., USSR). Phys. Lett.; 42B: No. 1, 24-6(13 Nov 1972).

A nonlocal separable potential is suggested for describing $\alpha-\alpha$ elastic scattering ($E_{lab} < 40$ MeV) for the partial waves L = 0, 2, 4, 6. The phase-shift analysis is made by using the method of least squares. (auth)

8521 DOUBLE CHARGE EXCHANGE ON ^{4}He AND ^{3}He LEADING TO MULTI-NEUTRON FINAL STATES. Perez-Mendez, V.; Sperinde, J. (Univ. of California, Berkeley). pp 3.21-36 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The following three reactions were studied: $\pi^- + {}^4\text{He} \rightarrow \pi^+ + 4n$, $\pi^- + {}^4\text{He} \rightarrow p + 3n$, and $\pi^- + {}^3\text{He} \rightarrow \pi^+ + 3n$ for $E\pi^- = 140$ MeV. The energy distribution of the detected π^+ is given; it determines the energy distribution of the 4n or 3n system. The lines shown on the graph are in phase space and phase space modified by neutron interactions in a $^1S_0$ final state. No evidence for a 4n or a 3n bound system was obtained. The combination of the spectator model with a final-state interaction between the three neutrons led to a good fit; a resonant behavior for the three neutrons was also envisaged. (8 figures) (France)

8522 EXPERIMENTAL ASPECTS OF RADIATIVE PION CAPTURE IN NUCLEI. Truoel, P. (Univ., Zurich). pp 5.65-92 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The present state of research in the field of radiative pion capture by nuclei is presented. The various experimental methods used for investigating the phenomena are reviewed: the activation technique, detection and spectroscopy of the decay neutron, and the detection of the high-energy photon. The different targets are presented (D, T, ^{3}He, ^{4}He, ^{6}Li, ^{12}C, ^{16}O, Mg, ^{32}S, ^{40}Ca, Cu) together with the corresponding measurement methods. For completeness, measurements which are in progress or have been proposed for particular meson production centers are also included. (13 figures) (France)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 8295, 8338, 8514, 8522, 8569, 8572, 8574, 8596, 8611, 8628, 8722, 8739, and 8742.

8523 (COO-1573-107) ^{16}O(d,n) POLARIZATIONS AND CROSS SECTIONS FROM 3 TO 4 MeV. Anderson, B. D.; Velkley, D. E.; Willard, H. B. (Case Western Reserve Univ., Cleveland, Ohio). [nd]. 31p. Dep. NTIS.

The cross sections and polarizations of the neutron groups from the ^{16}O(d,n)^{17}F reaction leading to the ground and first excited states of ^{17}F have been measured in the deuteron energy range from 3 to 4 MeV. Time-of-flight techniques were employed throughout. Calculations were performed to determine to what extent the DWBA theory could describe the experimental results. The cross-section angular distributions and the highest energy ground state polarization angular distribution could all be reproduced simultaneously with only small modifications made to optical-model analyses of recent elastic scattering measurements. The other polarizations appear to be affected by large compound-nucleus contributions and could not be reproduced simultaneously. Spectroscopic factors were extracted and are in satisfactory agreement with those obtained by previous workers. (auth)

8524 COULOMB EXCITATION OF THE $\frac{1}{2}^-$ STATE IN ^{7}Li. Bamberger, A.; Jansen, G.; Povh, B.; Schwalm, D.; Smilansky, U. (Max Planck Inst. fuer Kernphysik, Heidelberg). Nucl. Phys.; A194: No. 1, 193-204(1972).

Coulomb excitation of the $\frac{1}{2}^-$ state in ^{7}Li was induced by scattering ^{7}Li on ^{208}Pb and ^{209}Bi targets. The excitation probabilities were measured for a wide range of scattering angles and bombarding energies. The deviations of the measured excitation probabilities from the predictions of first-order Coulomb excitation theory were analyzed in terms of the reorientation effect. With the inclusion of contributions from virtual E1 excitations of the α + t channel it was possible to give an estimate of the ground state quadrupole moment and the B(E2, $\frac{3}{2} \rightarrow \frac{1}{2}$) value which are consistent with the results of previous independent measurements. (auth)

8525 ANOMALOUS QUASI-ELASTIC CROSS-SECTION OF ELECTRON ON ^{12}C. Berthot, J.; Isabelle, D. B. (Univ., Clermont-Ferrand, France). Lett. Nuovo Cim.; 5: No. 2, 155-9(9 Sep 1972).

The quasi-elastic scattering of electrons has been studied extensively over the last few years at Orsay. In the course of this study it was found that for ^{12}C there seems to exist on the high-excitation energy side of the quasi-elastic peak some "bumps" which are not predicted by the presently available theoretical calculation. It is concluded that all experimental facts demonstrate the existence of an anomalous behavior of the quasi-elastic cross section for ^{12}C. (W.D.M.)

8526 DETERMINATION OF THE NUCLEAR MOMENTS OF SODIUM USING HYPERFINE STRUCTURE CONSTANTS. Mashinskii, A. L.; Shtoff, A. V. Opt. Spectrosc. (USSR) (Engl. Transl.); 32: No. 3, 231-4(Mar 1972).

Translated from Opt. Spektrosk.; 32: No. 3, 441-7(Mar 1972).

The nuclear moments of sodium are calculated from the constants of magnetic–electric coupling of the nucleus and the optical electrons in the $3^2P_{\frac{3}{2}}$ state. The constants are determined by the level-crossing method. The antiscreening effect caused by polarization of the atomic shell is taken into account in the calculation. (auth)

8527 TOTAL PHOTONEUTRON CROSS SECTIONS FOR ^{12}C AND ^{19}F. van de Vyver, R. E.; Ferdinande, H.; Knuyt, G.; Carchon, R.; Devos, J. (State Univ., Ghent). Nucl. Phys.; A198: No. 1, 144-52(1972).

The total photoneutron cross sections for ^{12}C and ^{19}F were measured from threshold to 33 and 19 MeV respectively, with the use of bremsstrahlung from a linac and by direct detection of the neutrons. The yield curves were analyzed using the variable-bin Penfold and Leiss unfolding technique, and the least-structure method of Cook. The ^{12}C data are in good agreement with available results; the $^{19}F(\gamma,xn)$ cross section shows considerable fine structure, not observed in neighboring odd-mass nuclei. (auth)

8528 ANGULAR CORRELATION AND REACTION MECHANISM FOR $^{11}B(p,\alpha)^8Be_{2.9}(\alpha)^4He$ WITH $E_p < 1.4$ MeV. Treado, P. A.; Lambert, J. M.; Alessi, V. E.; Kane, R. J. (Georgetown Univ., Washington, DC). Nucl. Phys.; A198: No. 1, 21-32(1972).

The α–α angular correlation from the sequential decay of the $^{11}B(p,\alpha)^8Be_{2.9}(\alpha)^4He$ reaction indicates that this reaction proceeds by compound-nucleus formation of ^{12}C states of E_x, J^π = 16.11(2^+), 16.58(2^-) and 17.23(1^-). For E_p = 0.163, 0.675, 1.00 and 1.39 MeV, and for a first-emitted α-particle angle of 90°, kinematically complete experiments provide observed symmetry axes for the $^8Be_{2.9}$ break-up distribution in its own cm system. The axis for each correlation function, when compared to the momentum transfer and recoil directions associated with various possible mechanisms, indicates that compound-nucleus formation is the predominating mechanism at each beam energy. The correlation functions at the resonant proton energies of 0.163, 0.675 and 1.39 MeV are consistent with the capture states having J^π = 2^+, 2^- and 1^-, respectively. (auth)

8529 SCATTERING OF PROTONS BY ^{14}N IN THE ENERGY RANGE 17 TO 26.5 MeV. Lutz, H. F.; Heikkinen, D. W.; Bartolini, W. (Univ. of California, Livermore). Nucl. Phys.; A198: No. 1, 257-67(1972).

Excitation functions taken at 100 keV steps and extending from 17 MeV to 26.5 MeV have been obtained for the elastic scattering of protons by ^{14}N and also the inelastic scattering exciting the levels at 2.31 MeV and 3.95 MeV. The excitation functions were obtained at c.m. angles of 90°, 125°, and 160°. No evidence for resonance behavior was seen in the energy region covered. Angular distributions for the elastic 2.31 MeV and 3.95 MeV levels were obtained at 18, 21, 23, and 26 MeV bombarding energy. The elastic scattering was analyzed with the optical model. The transition from the J^π; T = 1^+; 0 ground state to the J^π; T = 0^+; 1 level was analyzed using Visscher–Ferrell wave functions and a central plus tensor interaction. The strength of the tensor interaction was deduced. Using a range parameter α = 0.71 fm^{-1} and a regularizing parameter β = 2 fm^{-1}, V_T was found to be 5.5, 5.6, 5.0, and 4.2 MeV at 18, 21, 23, and 26 MeV bombarding energy. (auth)

8530 PROTON SMALL ANGLE MULTIPLE SCATTERING AT 600 MeV. Hungerford, E. V. (Rice Univ., Houston, TX); Mutchler, G. S.; Phillips, G. C.; (and others). Nucl. Phys.; A197: No. 2, 515-28(1972).

The small-angle multiple scattering of 600-MeV protons from targets of C, Al, Cu, Cd, and Pb has been observed using two-dimensional multiwire proportional detectors (MWPC) placed in the proton beam. Data with high statistical accuracy near zero degrees are presented for the first time. The results compared to a modified Molière calculation agree within a few percent for the rms Gaussian angle, but the data do not decrease with angle as rapidly as the Molière prediction for angles greater than 3 or 4 times the rms angle for the lighter targets. The deviation in the tail of the distributions is especially evident in carbon, and is attributed to the presence of nuclear scattering and the finite size of the target nucleus. The present theories are not able to reproduce these tail distributions. (auth)

8531 PHOTODISINTEGRATION OF ^{14}N: CROSS SECTION AND ANGULAR DISTRIBUTION FOR $^{14}N(\gamma,p_0)$. Carr, R. W. (Yale Univ., New Haven); Baglin, J. E. E.; Bentz, E. J. Jr. Phys. Rev., C; 6: No. 6, 2032-8(Dec 1972).

The absolute cross section and angular distribution for the $^{14}N(\gamma,p_0)$ process were measured in the giant-resonance energy range from 17 to 25 MeV. Between 17 and 21 MeV, the large angular anisotropy requires mixing of at least two dominant E1 reaction channels. Above 22 MeV, d-wave emission from 2^- states appears to dominate. Admixture of about 5 to 10% of E2 and/or M1 strength is observed at all energies. The observations are qualitatively consistent with shell-model predictions. (8 figures, 1 table) (auth)

8532 COMMENT ON ROTATIONAL BANDS IN ^{19}F. Bingham, H. G.; Fortune, H. T. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C.; 6: No. 5, 1900-1(Nov 1972).

A recent suggestion that the 4.385-MeV $^7/_2{}^+$ state in ^{19}F is in the ground-state rotational band and that the 5.473-MeV $^7/_2{}^+$ state is in an excited band appears to be contradicted by γ-decay data and by data from the $^{16}O(^6Li, ^3He)^{19}F$ reaction—both of which assign the 5.473-MeV state to the ground-state band. (1 table) (auth)

8533 ELASTIC SCATTERING OF PIONS ON ^{16}O NEAR THE (3-3)-RESONANCE ENERGY: A SELF-CONSISTENT CALCULATION. Engelberg, D. P. (Queensborough Community Coll., Bayside, NY). Phys. Rev., C.; 6: No. 5, 1620-32(Nov 1972).

An optical potential for elastic scattering of mesons on a nucleus, which is self-consistent at all distances from the center of the nucleus, is developed theoretically. Application is made to the case of scattering of pions on ^{16}O in the (3-3)-resonance energy region for the Fermi-gas model and the shell model of the nucleus. Pair correlations are included. Energy-dependent empirically fitted parameters are used as inputs for the pion–nucleon interaction. For the shell model a downward energy shift of 30 to 45 MeV, as well as considerable broadening, is predicted for the (3-3) pion–nucleus resonance. Graphs of the differential cross section for various energies are included, with discussion of some significant features. Effects of inclusion and exclusion of the self-consistency requirement are considered. (8 figures) (auth)

8534 RADIATIVE CAPTURE OF ^3He BY ^9Be FROM 1 TO 6 MeV. Blatt, S. L. (Ohio State Univ., Columbus); Moon, K. J.; Kohler, D. Phys. Rev., C.; 6: No. 5, 1536-42(Nov 1972).

The radiative-capture reaction $^9Be(^3He,\gamma)^{12}C$ was studied in the bombarding energy range $1.0 \leq E(^3He) \leq 6.0$ MeV. Transitions to the ground state and first two excited states were seen. Excitation curves and angular distribution measurements indicate a broad resonance near 2.55 MeV, formed by s- and d-wave capture, suggesting the presence of a 1^-, T = 1 state of ^{12}C at 28.2 MeV. The transitions to the two 0^+ final states are strong, and show strikingly similar energy dependence. A simple interpretation of the observations in terms of a particle–hole picture of ^{12}C is presented. (5 figures, 1 table) (auth)

8535 $^{16}O(d,n)$ POLARIZATIONS AND CROSS SECTIONS FROM 3 TO 4 MeV. Anderson, B. D.; Velkley, D. E.; Willard, H. B. (Case Western Reserve Univ., Cleveland). Phys. Rev., C.; 6: No. 5, 1513-21(Nov 1972).

The cross sections and polarizations of the neutron groups from the $^{16}O(d,n)^{17}F$ reaction leading to the ground and first excited states of ^{17}F were measured in the deuteron energy range from 3 to 4 MeV. Time-of-flight techniques were employed throughout. Calculations were performed to determine to what extent the distorted-wave Born-approximation theory could describe the experimental results. While the cross-section angular distributions could be reproduced well, the polarization calculations were generally quite different from the experimental results, although "suggestive" in a few cases. Compound-nucleus contributions to the data appear to be significant. Spectroscopic factors were extracted and are in satisfactory agreement with those obtained by previous workers. (5 figures, 2 tables) (auth)

8536 NEUTRON AND PROTON SPECTRA FROM TARGETS BOMBARDED BY 450-MeV PROTONS. Wachter, J. W.; Gibson, W. A.; Burrus, W. R. (Oak Ridge National Lab., TN). Phys. Rev., C.; 6: No. 5, 1496-1508(Nov 1972).

The energy spectra of secondary neutrons in the energy region between 100 and 450 MeV emitted by targets bombarded by 450-MeV protons were measured using a proton-recoil spectrometer.

Secondary-proton measurements were also made with this spectrometer. The measurements were made on Be, C, Al, Cu, Co, Pb, and Bi targets and at several angles between 0 and 60°. Two general target thicknesses were employed: thin targets in which the primary beam lost little energy and in which further interaction of the secondary particle was small; and thick targets in which the primary beam lost all or a significant fraction of the initial energy and in which the probability of the secondary particles undergoing further interaction was large. The thin-target results are expressed as cross sections; the thick-target results represent a nucleon transport and are expressed as a yield. A number of comparisons of the cross-section results against the Bertini intranuclear-cascade model indicate reasonable agreement for most secondary-proton data and some secondary-neutron data. In the latter case, the position of the observed quasi-free scattering peak is at an unexpectedly low energy. (20 figures, 7 tables) (auth)

8537 HALF-LIFE OF ^{10}Be: A CORRECTION. McMillan, E. M. (Univ. of California, Berkeley). Phys. Rev., C; 6: No. 6, 2296(Dec 1972).

A mistake in computing the result of an earlier determination of the half-life of ^{10}Be is pointed out. The corrected value is $(1.7 \pm 0.4) \times 10^6$ y. (auth)

8538 CORRELATED NEUTRON–DEUTERON AND NEUTRON–TRITON EMISSION AFTER PION CAPTURE ON ^{12}C. Lee, D. M.; Minehart, R. C.; Sobottka, S. E.; Ziock, K. O. H. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A197: No. 1, 106-10 (1972).

Energy and angle measurements of neutron–deuteron and neutron–triton pairs emitted following negative–pion capture on ^{12}C have been made. Strong 180° correlation is observed in the angular distributions of both types of pairs, indicating substantial absorption by clusters in the ^{12}C nucleus. (auth)

8539 PHOTON-INDUCED NUCLEAR REACTIONS ABOVE 1 GeV. I. EXPERIMENTAL. Andersson, G. (Lund Inst. of Tech., Sweden); Blomqvist, I.; Forkman, B.; (and others). Nucl. Phys.; A197: No. 1, 44-70(1972).

The yields of the reactions ^{12}C(γ,n)^{11}C, ^{27}Al(γ,π$^+$)^{27}Mg, ^{27}Al(γ,2pn)^{24}Na, ^{127}I(γ,ypxn) and ^{197}Au(γ,xn) have been measured in the energy range 1–7 GeV by the activation method without chemical separation. The yields and the F/B ratios in the photofission of Au and Pb have been measured by glass-plate detectors. From the yields the cross sections have been deduced. Further, the mass distribution from ^{238}U photofission was measured. The results fit well to earlier measurements below 1 GeV. The analysis and discussion of the spallation and fission results are given in a series of consecutive papers. (auth)

8540 STUDY OF THE OFF-ENERGY-SHELL n–^{15}N TOTAL CROSS SECTION BY MEANS OF ^{15}N(d,p) STRIPPING INTO THE CONTINUUM OF ^{16}N. Fuchs, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Homeyer, H.; Oeschler, H.; Lipperheide, R.; Moehring, K. Nucl. Phys.; A196: No. 2, 286-302(1972).

The ^{15}N(d,p) reaction leading to unbound states of ^{16}N has been studied at E_d = 12 MeV. The proton spectra display patterns very similar to the energy dependence of the corresponding n–^{15}N total cross section, including interference phenomena between resonances and continuum. The variation of resonance intensity with momentum transfer in the (d,p) reaction probes the off-energy-shell behavior of the neutron scattering amplitude. A simple approximation is discussed, in which the off-shell effect is attributed mainly to a momentum dependence expressed by penetration factors. This model is found to give a semiquantitative description of the differential cross sections of ^{15}N(d,p), and presents a new and sensitive method for the determination of resonance angular momenta l. Spectroscopic results for ^{16}N resonances are given. (auth)

8541 PROCEEDINGS OF THE INTERNATIONAL SEMINAR ON π MESON–NUCLEUS INTERACTIONS, STRASBOURG, FRANCE, SEPTEMBER 20, 1971. Strasbourg; Universite Louis Pasteur ([1971]). vp. (In French and English). (CONF-710948).

Thirty-one papers were presented in five sessions entitled: π-mesic atoms, scattering without charge exchange, scattering with charge exchange, experimental facilities, absorption of π mesons on nuclei. The papers were abstracted separately for NSA. (France)

For abstracts of individual papers see: 8002–8004, 8231–8234, 8399, 8521, 8522, 8542–8556, and 8738–8743.

8542 PION–NUCLEUS SCATTERING: EXPERIMENT. Binon, F. (European Organization for Nuclear Research, Geneva). pp 2.25-60 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The experimental methods used to study elastic π scattering are presented together with the results obtained with ^{4}He, ^{12}C, and ^{16}O nuclei. The results obtained for the forward charged-π–nucleus scattering amplitude are compared with the predictions of the π–nucleus forward dispersion relations. The angular distributions obtained for the charged-π–^{4}He scattering are given. The results of a phase-shift analysis are compared with those obtained using the Glauber model. Most of the results presented were obtained at medium energies (<500 MeV), although some results obtained for ^{4}He at high energies (>1 GeV) are also presented; such results are interesting as they illustrate the possibilities of measuring the recoil of the nucleus. (18 figures) (France)

8543 RESULTS OF A PHASE-SHIFT ANALYSIS OF π$^-$–^{12}C SCATTERING. Beiner, J.; Huguenin, P. pp 2.73-5 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The coefficients of the partial wave expansion for the scattering amplitude were determined by fitting the measured cross sections. A model derived from the eikonal model was used to obtain partial wave coefficients involving an impact parameter greater than 3fm. (France)

8544 ELASTIC AND INELASTIC π$^-$–^{12}C SCATTERING. Amiet, J. P.; Germond, J. F. pp 2.76-8 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The many-channel extension of the pion–nucleus optical potential was used to calculate the differential and total cross sections for π$^-$–^{12}C scattering in which the target nucleus is left in the ground state or in the first excited 2$^+$ state. (France)

8545 TOTAL ACTIVATION CROSS SECTION RATIOS AT THE (3,3) RESONANCE FOR (π$^+$,πN) REACTIONS ON ^{19}F, ^{31}P, AND ^{64}Zn. Plendl, H. S. (Florida State Univ., Tallahassee); Robson, D.; Umbarger, C. J.; Burch, D. F.; Richter, A. pp 2.79-81 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Measurements of the total activation cross sections for nucleon knock-out reactions induced by π$^+$ or π$^-$ beams in target nuclei with a nonzero isospin were performed. The $\sigma(\pi^+)/\sigma(\pi^-)$ cross section ratios measured for ^{19}F, ^{31}P, and ^{64}Zn target nuclei are given for E_π = 184 MeV. (France)

8546 SIMPLE CHARGE-EXCHANGE REACTIONS. Joseph, C. (Univ., Lausanne, Switzerland). pp. 3.15-19 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Papers recently published on charge-exchange reactions of the $\pi^\pm + {}_ZA \rightarrow \pi^0 + {}_{Z\pm1}A$ type are briefly surveyed. Analogies with (p,n) reactions are made. The resonant behavior of the cross section is demonstrated. The population of isobaric analogue states is also considered. (France)

8547 USE OF π MESONS TO PROBE THE NUCLEAR STRUCTURE OF LIGHT NUCLEI (^{12}C,^{14}N,^{16}O) BY ANALYZING THEIR INTERACTIONS (DOUBLE CHARGE EXCHANGE). Massue, J. P.; Sakamoto, Y.; Kaiser, R.; Batusov, I. (Centre National de la Recherche Scientifique, Strasbourg). pp 3.37-40 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The double charge exchange interaction of π mesons with ^{12}C was studied at 140, 185, and 240 MeV. The total cross section was determined in bubble chamber experiments. The mechanism of the reaction was investigated by analyzing stars produced in nuclear emulsions. (France)

8548 NONRADIATIVE ABSORPTION OF π$^-$ MESONS (EXPERIMENTAL). Cernigoi, C. (Univ., Trieste, Italy). pp 5.17-40 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

In the case of pion absorption, the direct interaction mechanism

is interpreted as the elementary process: $\pi^- + 2N \rightarrow N + N$. The absorption process may take place with a nucleon cluster, the most likely process being the two nucleon process. The results obtained for pion interactions with ^{4}He, ^{6}Li, ^{7}Li, ^{14}N, and ^{16}O are given; the angular distributions of the emitted n–n and n–p are presented. Very different results are obtained with more complex nuclei. (France)

8549 PION RADIATIVE CAPTURE IN COMPLEX NUCLEI (THEORY). Figureau, A. (Univ., Lyon). pp 5.41-63 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The available experimental data on radiative pion absorption are briefly reviewed for nuclei from ^{3}He to Pb (except hydrogen and deuterium), particular attention being given to ^{3}He, ^{6}Li, ^{12}C, and ^{16}O. The impulse approximation is in good agreement with the data; the relation with muon capture in nuclei is generalized using the elementary particle approach. Precise tests of the theory are discussed: tests on the soft-pion theory, and tests on pion photoproduction. (4 figures, 58 references) (France)

8550 POSITIVE PION PRODUCTION ON ^{12}C AND ^{9}Be INDUCED BY 185 MeV PROTONS. Dahlgren, S.; Grafstroem, P.; Hoeistad, B.; Aasberg, A. (Uppsala Univ.). pp 5.93-106 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Differential cross sections for positive pion production with ^{12}C and ^{9}Be, using 185-MeV protons, are determined. Angular distributions for pionic proton capture by discrete final states in ^{13}C are presented. (France)

8551 NEW MEASUREMENTS OF $(\pi^+,2p)$ REACTIONS ON LIGHT NUCLEI. Amato, J. (Los Alamos Scientific Lab., N. Mex.); Burman, R. L.; Macek, R.; (and others). pp 5.109-12 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Preliminary results of new measurements on the $(\pi^+,2p)$ reactions with ^{6}Li, ^{14}N, and D_2O targets using 70-MeV pions are presented. The experimental relative cross sections are given for each ΔM peak as a distribution in $\cos^2 \theta_{cm}$ (θ_{cm} is the c.m.s. (π,p) angle of the two outgoing protons). The excitation spectra are shown. (France)

8552 CROSS SECTIONS FOR (π^+,p) REACTIONS ON ^{9}Be, ^{12}C, AND ^{16}O. Amato, J. (Los Alamos Scientific Lab., N. Mex.); Burman, R.; Macek, R.; (and others). pp 5.113-16 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The upper limits of the (π^+,p) cross sections were measured for ^{9}Be, ^{12}C, and ^{16}O targets ($E(\pi) = 70$ MeV). The emitted protons were identified in both $(\pi^+,2p)$ and (π^+,p) reactions. The excitation energy spectra and measured cross sections are given. The thresholds for several reactions with 3 or 4 particles in the final state are also given. (France)

8553 NUCLEAR SCATTERING OF PIONS AND NUCLEAR STRUCTURE. Kohmura, T. (Tokyo Univ. of Education). pp 5.117-21 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Data obtained from the analysis of high-energy (500 MeV/c) nuclear scattering experiments are reviewed. Information on the short-range structure of nuclei has been obtained such as the nuclear surface and the nucleon–nucleon correlations. (France)

8554 USE OF π MESONS AS PROBES IN THE INVESTIGATION OF THE NUCLEAR STRUCTURE OF LIGHT NUCLEI ^{12}C, ^{14}N, ^{16}O BY ANALYSIS OF THEIR IN-FLIGHT INTERACTIONS. Massue, J. P.; Sakamoto, Y.; Kaiser, R.; Batusov, I. (CNRS, Strasbourg). pp 5.122-5 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971). (In French).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The absorption of π^+ mesons by light nuclei (^{12}C, ^{14}N, and ^{16}O) was studied. 6000 absorption stars were observed; the distribution of their visible branches are presented. A preliminary stage occurs in which the π^+ is absorbed by a substructure (generally two nucleons) followed by a second stage involving the de-excitation of the residual nucleus. (France)

8555 EXPERIMENTAL TECHNIQUES AND RELATED PROBLEMS. Isabelle, D. B. (Univ., Clermont-Ferrand, France). pp 6.13-18 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The experimental techniques and related problems discussed at the International conference on pion–nucleus interactions held in Strasbourg (Sept. 1971) are briefly surveyed. A crucial problem involved in this field is the monitoring of the beam. The concepts involved in designing high-resolution spectrometers are discussed. Coherent scattering experiments recently performed are described. (France)

8556 CONCLUDING SUMMARY. Feshbach, H. (Massachusetts Inst. of Tech., Cambridge). pp 7.1-11 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The discussion and results presented at the conference are reviewed. Pion–nucleus interactions occurring with pionic atoms and in elastic scattering experiments are considered. The following problems are analyzed: the various nuclear models proposed; nuclear structure dependence; the use of charge-exchange reactions as nuclear probes. The data are analyzed using phase-shift techniques, the optical model, and the Glauber diffraction model. The discrepancies between the experimental results obtained from pion absorption and production measurements, and the theoretical predictions on the final states of the single nucleon are emphasized. The information which can be obtained from experiments on radiative π^- capture by light nuclei is discussed. (France)

Nuclear Properties and Reactions, $20 \leq A \leq 38$

Refer also to abstracts 8514, 8522, 8530, 8536, 8539, 8611, 8628, and 8713.

8557 (COO–1573–113) NUCLEAR PHYSICS LABORATORY FINAL REPORT, FEBRUARY 1, 1972–AUGUST 31, 1972. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). 1972. Contract AT(11-1)-1573. 8p. Dep. NTIS.

Research by the Nuclear Physics Laboratory of Case Western Reserve University from February 1 through August 31, 1972 is reported. Some unpublished results on angular distributions and excitation functions for the ^{28}Si(^{3}He,n) reaction are included. (J.W.R.)

8558 (FRNC-TH-275) STUDY OF (p,t) AND (p,^{3}He) REACTIONS WITH CERTAIN NUCLEI WITH NEARLY FILLED s–d SHELLS. ANALYSIS IN TERMS OF THE SHELL MODEL. Vignon, Bernard (Grenoble Univ. (France)). 1972. 95p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Experimental studies of the ^{33}S–^{33}Cl and ^{37}Ar–^{37}K mirror nuclei as well as ^{35}S–^{35}Cl nuclei using (p,t) and (p,^{3}He) reactions enabled the existence of numerous $T = T_z + 1$ states to be established and certain of their characteristics to be determined. Already known values for the spin and parity were confirmed for the first $T = T_z$ isospin excited states. No known negative parity levels were observed; contributions from deep lying levels such as the p shell and two stage processes with the f shell were sufficiently weak to be neglected. The cross section is sensitive to configuration mixing in the wave functions (particularly with respect to their phases). The cross sections obtained using coherent configuration mixing and evaluated from the shell model are in good agreement with the experimental results. The use of an interaction between the proton and the two transferred nucleons depending on the spin and isospin enabled their exact reproduction for (p,t) and (p,^{3}He) reactions. The results obtained enable the wave functions to be tested for the shell model. Comparisons with the calculations for statistical moments and the rate of the electromagnetic transitions enable the value of the method to be demonstrated. (France)

8559 (KFK-1611) MEASUREMENT AND FLUCTUATION ANALYSIS OF γ PRODUCTION CROSS SECTION FROM INELASTIC NEUTRON SCATTERING ON ^{56}Fe AND ^{27}Al BETWEEN 0.8 AND 13 MeV. Voss, F. (Kernforschungszentrum, Karlsruhe

(West Germany). Institut fuer Angewandte Kernphysik). Apr 1972. 65p. (In German). Dep. NTIS (U. S. Sales Only).

A new two-parameter-experiment for the measurement of high resolution γ-ray production cross sections from inelastic neutron scattering is described. The excitation functions of four γ-transitions in ^{56}Fe and five γ-transitions in ^{27}Al have been measured in the energy range from 0.8 to 13 MeV. A fluctuation analysis was carried out using an autocorrelation function and average level widths of the compound nuclei ^{57}Fe and ^{28}Al were determined. In the case of aluminum a significant dependence of the correlation widths on the exit channel was found. The excitation functions were investigated for intermediate structure. Some of the prominent structure appeared correlated in different inelastic channels suggesting the possible existence of doorway states. (auth)

8560 MEASUREMENTS OF ELECTRON CAPTURE PROBABILITIES. Genz, Harald D. Atlanta; Emory Univ. (1971). 164p. University Microfilms Order No. 72-15,451.

Thesis.

The orbital electron capture ratios, P_L/P_K and P_M/P_L in the radioactive decay of ^{55}Fe and ^{71}Ge, and P_M/P_L in the decay of ^{37}Ar, are measured using gaseous sources in single- and multiwire proportional counters. A comparison with the current theoretical predictions indicates that L/K capture ratios are not sensitive to the different electron wave functions used or to different approaches adopted for the calculation of the exchange correction factors. The M/L capture ratios obtained in the present work favor the wave functions by Watson and Freeman at low Z and those by Suslov at high Z with exchange correction factors by Vatai. The K-electron capture probabilities P_K for allowed and first-forbidden transitions in the decay of ^{151}Gd are measured by K-x ray-gamma coincidence method and compared with theory. The multiwire proportional counter technique is also utilized in the precision determination of K-shell fluorescence yield ω_K for Gallium. (Diss. Abstr. Int., B)

8561 ENERGY LEVELS OF ^{34}S FROM THE ^{33}S(d,p)^{34}S REACTION. Crozier, D. J. (Argonne National Lab., IL). Nucl. Phys.; A198: No. 1, 209-27(1972).

The energy levels of ^{34}S have been studied with the ^{33}S(d,p)^{34}S reaction at E_d = 12 MeV. A split-pole magnetic spectrograph was used to record the deuteron spectra at 10 angles from 9° to 59°. An over-all energy resolution of 16 keV was achieved. The results make possible the identification of the major components of the $1d_{\frac{3}{2}}$ $1f_{\frac{7}{2}}$, T = 1 configuration. The two-body matrix elements of the $d_{\frac{3}{2}}$ $f_{\frac{7}{2}}$ interaction are compared with other known $d_{\frac{3}{2}}$ $f_{\frac{7}{2}}$ multiplets and with theoretical calculations. (auth)

8562 INVESTIGATION OF THE ^{32}S(^{3}He,p)^{34}Cl REACTION. Nann, H. (Univ., Frankfurt am Main); Armbruster, L.; Wildenthal, B. H. Nucl. Phys.; A198: No. 1, 11-20(1972).

The ^{32}S(^{3}He,p)^{34}Cl reaction has been studied at an incident energy of 24 MeV. The proton spectra were analyzed with a multiangle magnetic spectrograph and angular distributions have been measured for states in ^{34}Cl up to 3.4 MeV of excitation energy. Two sets of shell-model wave functions, which use the same configuration space but different treatments of the effective residual interaction, are tested by comparing two-nucleon transfer DWBA calculations with the experimental angular distributions. (auth)

8563 EXPERIMENTAL STUDY OF ELECTROMAGNETIC TRANSITIONS IN THE ^{28}Mg NUCLEUS. Fintz, P.; Rastegar, B.; Davison, N. E.; (and others) (Univ. Louis Pasteur, Strasbourg). Nucl. Phys.; A197: No. 2, 423-9(1972). (In French).

The first five excited states of ^{28}Mg have been studied by observing γ-rays from the ^{26}Mg(t,pγ)^{28}Mg reaction, in coincidence with protons, in NaI(Tl) and Ge(Li) detectors, at incident energies between 2.5 and 3.2 MeV. Doppler-shift attenuation measurements lead to the mean-lives τ_m = 2.0 ± 0.4 ps, 1.1 ± 0.3 ps and 96 ± 30 fs for the levels at 1.47, 3.86 and 4.02 MeV, respectively, and to upper limits of τ_m < 50 fs and <120 fs for the levels at 4.56 and 4.88 MeV. Angular correlation measurements (method II) were used to determine spins, mixing ratios and γ-branching ratios. The 4.02 MeV level has most probably $J^\pi = 4^+$. (auth)

8564 STUDY OF γ TRANSITIONS IN THE ^{35}S NUCLEUS. Freeman, R. M.; Faerber, R.; Toulemonde, M.; Gullmann, A. (Univ. Louis Pasteur, Strasbourg). Nucl. Phys.; A197: No. 2, 529-39(1972). (In French).

The reaction ^{34}S(d,pγ)^{35}S has been used to study levels of ^{35}S below an excitation energy of 4.50 MeV. The excitation energies and γ-ray decay scheme were determined for 13 of the first 16 known excited states. The lifetimes of the 2347 keV (1.22 ± 0.18 ps), the 2718 keV (100 ± 35 fs) and the 3802 keV (36 ± 26 fs) levels were measured, and limits for lifetimes have been set on five other levels. Angular-correlation measurements imply a spin of $\frac{3}{2}$ for the 3802 keV level, and are in agreement with J^π values of $\frac{3}{2}^+$, $\frac{1}{2}^+$, $\frac{7}{2}^-$ and $\frac{3}{2}^-$ for the ground state and the 1572, 1991 and 2347 keV levels, respectively. The 1991 → 0 keV transition has a mixed M2−E3 character, with δ = +0.11 ± 0.04; the angular correlations for the 2347 → 0 and 2347 → 1572 keV transitions can be fitted simultaneously supposing both have pure E1 character. (auth)

8565 DECAY OF ^{28}P. Wilkinson, D. H. (Brookhaven National Lab., Upton, N. Y.); Goosman, D. R.; Alburger, D. E.; Marrs, R. E. Phys. Rev., C.; 6: No. 5, 1664-72(Nov 1972).

^{28}P was formed in the ^{28}Si(p,n)^{28}P reaction at E_p = 16.5 and 20 MeV, and its γ-ray spectrum was measured by means of two different target-transfer and Ge(Li) detector systems. γ-efficiency calibrations of the detectors were carried out with several radioactivity and neutron-capture γ-ray sources. Nine excited states of ^{28}Si up to 9382 keV were found to be populated in ^{28}P decay, and the various positron and γ-ray branching ratios were derived. The ^{28}P positron branch to the 1779-keV first excited state of ^{28}Si is $68.4^{+2.0}_{-2.8}$%. Comparison of this with the corresponding mirror β^- decay of ^{28}Al gives $(ft)^+/(ft)^- = 0.96^{+0.06}_{-0.08}$ in striking disagreement with the results derived from earlier experimental data. The ft of (2.95 ± 0.23) × 10^3 for ^{28}P β^+ decay to the ^{28}Si T = 1 analog state at 9316 keV agrees with that expected for a pure vector transition. A review is presented of mirror symmetry in even-A systems with the conclusion that they do not reveal significant evidence for second class currents. (2 figures, 5 tables, 38 references). (auth)

8566 ALPHA-PARTICLE SCATTERING FROM ^{28}Si AT 21 TO 28 MeV. Obst, A. W.; Kemper, K. W. (Florida State Univ., Tallahassee). Phys. Rev., C.; 6: No. 5, 1705-12(Nov 1972).

60-point angular distributions for the scattering of α particles to the first four states in ^{28}Si (0^+, 2^+, 4^+, 0^+) were measured from 21 to 28 MeV in 125-keV steps. Fluctuations with full width at half maximum of less than 300 keV were observed in all four channels. Compound-nucleus contributions to energy-averaged data were estimated (20% to the 2^+ state, 30% to the 4^+ and $0^+_{4,9}$ states) at 25.2, 26.2, and 27.2 MeV. Optical-model fits to the elastic scattering and coupled-channel fits to the 0^+, 2^+, 4^+ states give slightly better agreement with an angular-momentum-dependent absorption. The coupled-channel calculations give an over-all poor reproduction of the data, and it is not possible to extract a hexadecapole deformation for ^{28}Si. The extracted value of the quadrupole deformation parameter is $\beta_2 = -0.26 \pm 0.08$, while an upper limit can be placed on the hexadecapole deformation parameter $|\beta_4| \leq 0.1$. (8 figures, 3 tables) (auth)

8567 NUCLEAR CHARGE DISTRIBUTIONS OF ISOTONE PAIRS. I. ^{31}P AND ^{32}S. Sinha, B. B. P. (Univ. of Massachusetts, Amherst); Peterson, G. A.; Li, G. C.; Whitney, R. R. Phys. Rev., C.; 6: No. 5, 1657-63(Nov 1972).

Elastic cross sections for electron scattering from ^{31}P and ^{32}S are given for the momentum-transfer range from 0.7 to 2.9 fm^{-1}. The data were analyzed by means of a phase-shift code using phenomenological Fermi charge distributions modified with small undulations. The difference of the ^{31}P and ^{32}S charge distributions is compared with a $2s_{\frac{1}{2}}$ proton distribution and with other nuclear models. (6 figures, 5 tables). (auth)

8568 ACCURATE EXCITATION ENERGIES OF ^{27}Al FROM 5.4 TO 8.4 MeV AND IDENTIFICATION OF T = $\frac{3}{2}$ LEVELS. Kamykowski, E. A.; Browne, C. P. (Univ. of Notre Dame, Ind.). Phys. Rev., C.; 6: No. 5, 1644-9(Nov 1972).

Excitation energies of 57 states in ^{27}Al from 5.4 to 8.4 MeV were measured with accuracy of ±2 to ±3 keV. Energies of particles from the ^{27}Al(p,p')^{27}Al and ^{29}Si(d,α)^{27}Al reactions were measured with the Notre Dame 50-cm broad-range spectrograph. In the range 5.4 to 7.0 MeV values agree within 5.5 keV with other recent (p,p') work and within 4.6 keV with recent γ-ray work. Systematic discrepancies in the (p,p') values increasing to 20 keV at 8.3 MeV were found. Resolution was sufficient to measure excitation energies separated by 5 keV. The existence of two pairs of closely spaced levels in the region of the first T = $\frac{3}{2}$ state was confirmed. The first and second T = $\frac{3}{2}$ levels were identified by the low cross section of the ^{29}Si(d,α)^{27}Al reaction. The value of this accurately measured proton spectrum for calibration purposes is discussed. (5 figures, 2 tables). (auth)

8569 α-PARTICLE DECAYS OF THE 12.15-MeV STATE IN ^{20}Ne. Balamuth, D. P.; Noe, J. W.; Fortune, H. T.; Zurmuehle, R. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C.; 6: No. 5, 1694-7(Nov 1972).

The fractional branch for α-particle decay of the 12.15-MeV 6^+ state in ^{20}Ne to the 6.13-MeV 3^- state in ^{16}O was measured by coincident detection of 6.13-MeV γ rays and α particles from the reaction ^{12}C(^{12}C,α)^{20}Ne. The measured width ratio, $\Gamma_{\alpha'}/\Gamma$ = (6.0 1.5)%, together with the previously known quantity $\Gamma_{\alpha'}\Gamma_\alpha/\Gamma$ = 7.7 ± 3.8 eV, implies a ground-state width of Γ_α = 128 ± 72 eV.

The corresponding reduced width is about 10^{-3} of a single-particle unit: This value is consistent with the known small α-particle reduced widths for the 0^+, 2^+, and 4^+ states, which have been suggested to be members of a rotational band built on an 8p–4h intrinsic state. (3 figures, 1 table) (auth)

8570 E2-M1 MIXING IN THE γ DECAY OF THE 1.37-MeV STATE IN ^{28}Al. Lawergren, B. (Hunter Coll., New York). Phys. Rev., C.; 6: No. 5, 1691-3(Nov 1972).

E2/M1 mixing ratios of the decays of the 1.62-, 1.37-, and 0.03-MeV states in ^{28}Al are obtained from correlation measurements using a ^{28}Mg source. The smallness of the measured E2 component in the 1.37 → 0.03-MeV transition disagrees with recent shell-model calculations, but supports a rotational-model interpretation of some low-lying states. (1 figure, 2 tables) (auth)

8571 SHELL-MODEL CALCULATIONS FOR ^{22}Na AND ^{22}Ne. Preedom, B. M. (Univ. of South Carolina, Columbia); Wildenthal, B. H. Phys. Rev., C.; 6: No. 5, 1633-44(Nov 1972).

Shell-model calculations were performed for the nuclei ^{22}Na and ^{22}Ne. The model space was made up of all Pauli-allowed combinations of six particles in the orbits $0d_{5/2}$, $1s_{1/2}$, and $0d_{3/2}$. An inert ^{16}O core was assumed. The two-body interaction employed was obtained by empirically modifying some of the matrix elements of Kuo's interaction in order to achieve an rms best fit between the observed energies of 72 levels in the A = 18 to 22 region and the corresponding shell-model eigenvalues. Single-particle energies were taken from the ^{17}O spectrum. Calculated results for excitation energies, electromagnetic transition strengths, and spectroscopic factors for single-nucleon transfer are presented and compared with existing data. (5 figures, 12 tables) (auth)

8572 RECALCULATION OF MASS-TABLE PARAMETERS FOR NUCLEI Z ≤ 13 AND SOME EXPERIMENTAL CONSEQUENCES. Thibault, C.; Klapisch, R. (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France). Phys. Rev., C.; 6: No. 5, 1509-12(Nov 1972).

Using corrected input masses for odd–odd, T = 2 nuclei results in new values for the mass predictions of Garvey et al. The experimental consequences include the prediction that ^{17}B should be bound. (1 figure, 2 tables) (auth)

8573 Ar^+–C_2Cl_4 REACTIONS AND THEIR ROLE IN THE COLLECTION OF $^{37}Ar^+$ PRODUCED BY SOLAR NEUTRINOS. Leventhal, J. J.; Friedman, L. (Brookhaven National Lab., Upton, NY). Phys. Rev., D; 6: No. 11, 3338-9(1 Dec 1972).

A high-pressure gas phase study of the Ar^+–C_2Cl_4 ion-molecule system was made to determine relative rates of charge transfer and ion-molecule reaction. This study was initiated to investigate assumptions made concerning the collection of $^{37}Ar^+$ produced by the reaction $^{37}Cl(\nu,e^-)^{37}Ar$ in the Brookhaven solar neutrino experiment. Charge transfer was found to proceed at high pressures in the gas with a rate more than two orders of magnitude greater than other possible Ar^+–C_2Cl_4 ion-molecule reactions. These results support the argument that Ar^+ is not converted into stable charged species which might be missed with techniques used in the solar neutrino experiment. (auth)

8574 HIGH-SPIN STATES IN ^{22}Na. Hallock, J. N. (Massachusetts Inst. of Tech., Cambridge); Enge, H. A.; Sperduto, A.; (and others). Phys. Rev., C; 6: No. 6, 2148-52(Dec 1972).

Based on their selective population in the $^{12}C + {}^{14}N \rightarrow \alpha + {}^{22}Na$ reactions, states at E_x = 4.466, 4.522, and 4.708 MeV are suggested, respectively, as the 4^- member of the $K^\pi = 1^-$ band, the 7^+ member of the ground-state band, and the 5^+ member of the $K^\pi = 0^+$, T = 0 band. A very strongly populated state at 8.60 MeV may be the 8^+ member of the ground-state band. (3 figures, 1 table) (auth)

8575 STUDY OF ^{32}Si USING THE ^{30}Si(t,pγ) REACTION. Pronko, J. G.; McDonald, R. E. (Lockheed Palo Alto Research Lab., CA). Phys. Rev., C; 6: No. 6, 2065-74(Dec 1972).

Nuclear properties of the excited states of ^{32}Si were measured using the ^{30}Si(t,pγ) reaction at bombarding energies of E_t = 2.7 and 2.8 MeV. Angular correlations of γ rays were obtained using a spectrometer consisting of five NaI(Tl) counters in time coincidence with an annular particle detector positioned near 180°. Unique spin assignments for some of the excited states were obtained in addition to multipole-mixing-ratio and branching-ratio information. Nuclear lifetimes were measured using the Doppler-shift attenuation method. Some of the measured excitation energies, spins, and mean lifetimes [E_x(keV), J, and τ (ps), respectively] are as follows: 1942.5 ± 2.0, 2, 0.92 ± 0.30; 4985 ± 4, ≤2, ≤0.44; 5290 ± 3, 3, 0.27 ± 0.10; 5413 ± 3, 1, ≤0.074; 5956 ± 3, 2, ≤0.08; 6196 ± 5, 1, ≤0.055; 6385 ± 5, 2, ≤0.072. A hitherto unreported state at 4234 ± 4 keV was found to have a spin J = 2 and mean lifetime of τ = 0.38 ± 0.12 ps. The reported spectroscopic data are compared to the predictions of recent shell-model calculations. (11 figures, 4 tables) (auth)

8576 DEFORMATION TRENDS AMONG NUCLEI WITH 24 ≤ A ≤ 30: THE (^{3}He,p) AND (^{3}He,pγ) REACTIONS ON ^{24}Mg, ^{26}Mg, AND ^{28}Si. Lawergren, B. (Hunter Coll., New York); Beyea, J. Phys. Rev., C; 6: No. 6, 2082-90(Dec 1972).

The absolute differential cross sections of the (^{3}He,p) reactions on ^{24}Mg, ^{26}Mg, and ^{28}Si were measured at E_{He} = 10 MeV. The cross sections to various excited states are in reasonable agreement with rotational-model calculations except for a normalization factor which is different for each target nucleus. The evidence for rotational motion in ^{26,28}Al and ^{30}P is reviewed, and the differences in normalization factors are attributed to core overlap differences; in particular, the reduced yield in the ^{26}Mg(^{3}He,p)^{28}Al reaction reflects a large change in deformation between ^{26}Mg and ^{28}Al. In order to determine J^π values in ^{28}Al, γ-ray spectra were measured in coincidence with proton groups leading the certain high-lying states in ^{28}Al. A spin of $J^\pi = 1^+$ was established for a state at 3.105 MeV in ^{28}Al. (6 figures, 7 tables) (auth)

8577 LEVEL STRUCTURE OF ^{28}Al. Chen, S. (Ohio Univ., Athens); Rapaport, J.; Enge, H.; Buechner, W. W. Nucl. Phys.; A197: No. 1, 97-105(1972).

The energy-level structure of ^{28}Al has been studied by the ^{27}Al(d,p) reaction with 6.0 MeV incident deuterons. Thirty-six energy levels up to 5.13 MeV were analyzed. The angular distributions for the observed transitions are compared with distorted-wave Born approximation calculations. Angular momentum transfers are determined and spectroscopic strengths are deduced from the data. The results are compared with shell-model sum rules. (auth)

8578 $^{16}O(\alpha,\gamma)^{20}Ne$ CAPTURE γ-RAY MEASUREMENTS ON THE EXCITED $K^\pi = 0^+$ BANDS IN ^{20}Ne NEAR 7 MeV. Alexander, T. K.; Underwood, B. Y.; Anyas-Weiss, N.; (and others) (Nuclear Physics Lab., Oxford). Nucl. Phys.; A197: No. 1, 1-16(1972).

Radiative widths have been measured for the E_α = 3074 keV ($J^\pi = 0^+$), 3363 keV ($J^\pi = 2^+$), 3872 keV ($J^\pi = 2^+$), and 5368 keV ($J^\pi = 4^+$) resonances in the $^{16}O(\alpha,\gamma)^{20}Ne$ reaction, corresponding to level energies at 7191 ± 3, 7420 ± 1, 7826 ± 3, and 9029 ± 3 keV, respectively. The radiative widths for decay to the 2^+, first excited state and the 0^+, ground state of ^{20}Ne are: 7191 → 1633 (4.35 ± 0.75 MeV), 7420 → 1633 (29 ± 4 MeV), 7420 → 0 (≦3.0 ± 0.6 MeV), 7826 → 1633 (11.7 ± 1.6 MeV), 7826 → 0 (57 ± 7 MeV), and 9029 → 1633 (340 ± 42 MeV). The following upper limits on the decay widths to the 4^+, 4246 keV level were also obtained: 7420 → 4246 (<2.2 MeV), 7826 → 4246 (<2 MeV) and 9029 → 4246 (<6.8 MeV). The experimentally known interband electromagnetic matrix elements are compared with nuclear model predictions. The excitation energy region from 10.2 to 10.8 MeV in ^{20}Ne has been searched for a possible E_x → E(4^+, 4246 keV) transition and an upper limit of $\omega\gamma$ < 0.6 eV can be placed on such a transition. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 8513, 8514, 8522, 8546, 8553, 8558–8560, 8611, 8612, and 8712.

8579 (AWRE-O-72/72) MEASUREMENT OF (n,2n) CROSS SECTIONS FOR INCIDENT ENERGIES BETWEEN 6 AND 14 MeV. Mather, D. S.; Bampton, P. F.; Coles, R. E.; James, G.; Nind, P. J. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov 1972. 29p. (EANDC(UK)-142-AL). Dep. NTIS (U. S. Sales Only). UK 50 pence.

Cross sections for the (n,2n) and (n,3n) reactions have been determined for several fissionable materials between 6 and 14 MeV and non-fissionable samples between 12 and 14 MeV using a large liquid scintillator to count the neutrons directly. Measurements were made relative to the fission cross section of U-238 or Pu-239 for Sc, Nb, Mo, Y, Rh, Tm, Au, Pb, U-235, U-238 and Pu-239. The accuracy of the (n,2n) cross sections was generally in the range 6 to 10%. (auth)

8580 (LBL-1256) BETA ASYMMETRY FROM ORIENTED ^{52}Mn. Hung, Sammy Tung-Chuen (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 117p. Dep. NTIS.
Thesis.

The nuclear orientation technique has been used to investigate the mixed allowed beta transition of ^{52}Mn. Nuclei of ^{52}Mn were polarized in an iron lattice utilizing the adiabatic demagnetization

method to achieve low temperatures. The positrons emitted were detected with a high-purity germanium detector situated at the 1°K liquid helium bath. The angular distribution fits the correlation function $W(\theta) = 1 + (v/c)\ A\ (\langle m_\nu \rangle / I)\ \cos\theta$ and the asymmetry parameter A was determined. The Fermi to Gamow-Teller mixing ratio can be calculated from the experimental value of A if time-reversal invariance is assumed. The value of the mixing ratio was found to be -14.5%. This value represents the largest negative interference term to date on the ^{52}Mn mixed transition, although a comparable but positive interference term has been reported on the same nuclide. A large interference term implies that ^{52}Mn is a favorable candidate for further investigation on the time-reversal invariance property. However, many other serious experimental difficulties should be taken into consideration, and they are discussed in this report. To further test the accuracy of the system, the beta asymmetry of ^{60}Co was also measured. The value of A was found to be -0.971, which agrees well with the theoretical prediction of -1.00. (auth)

8581 (ORNL-TM-4007) RE-EVALUATION OF VANADIUM NEUTRON AND GAMMA-RAY PRODUCTION CROSS SECTIONS. Penny, S. K.; Owen, L. W. (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 34p. Dep. NTIS.

The cross sections for vanadium were re-evaluated with the emphasis placed on adding gamma-ray production files. The starting basis was the ENDF/B evaluation material 1017. The newly evaluated cross sections are in the ENDF/B format. (auth)

8582 ^{40}Ar(p,p′γ)^{40}Ar ANGULAR CORRELATION STUDIES OF ISOBARIC ANALOG LEVELS OF ^{41}Ar IN ^{41}K. Buerger, Kurt Herman. Lexington, Ky.; Univ. of Kentucky (1971). 138p. University Microfilms Order No. 72-21,447.

Thesis.

The ^{40}Ar(p,p′γ)^{40}Ar reaction has been used to investigate isobaric analog levels of ^{41}Ar in ^{41}K. Proton excitation functions, proton angular distributions, and p′–γ angular correlations for inelastically scattered protons leaving ^{40}Ar in its 1.46-MeV excited level have been acquired for several resonances in the proton bombarding energy region from 3.35 to 5.40 MeV. The Biedenharn angular correlation formalism has been used to yield information about incoming proton orbital angular momentum, intermediate level spin, outgoing proton orbital angular momentum, and outgoing particle spin amplitude mixing ratio. A listing of the computer program with which the analysis was performed is included. Additional information in the form of elastic scattering data for the prominent resonance at 5.21 MeV was analyzed using a modified Breit–Wigner analysis. Spectroscopic factors have been calculated and used together with the outgoing particle spin amplitude mixing ratio to obtain information about the wave functions of the resonant levels in ^{41}K and, by inference, about the wave functions of the parent analog levels in ^{41}Ar. For proton energy from 3.35 to 5.40 MeV, 27 peaks were observed in the excitation function for the 1.46-MeV level. The resonances at 3.39, 3.60, 3.65, 3.96, and 4.07 MeV were found to have $J^\pi = 3/2^-$; the resonance at 5.21 MeV was found to have $J^\pi = 5/2^+$. The $3/2^-$ resonances decay to the $J^\pi = 2^+$ 1.46-MeV excited level of ^{40}Ar with mixing of $p_{3/2}$ and $p_{1/2}$ waves; 97% of the $[(p_{3/2})_n {}^{40}\mathrm{Ar}(2_1^+)]$ strength has been identified. The $5/2^+$ resonance at 5.21 MeV decays to the 1.46-MeV level of ^{40}Ar by pure $s_{1/2}$ waves. (Diss. Abstr. Int., B)

8583 STUDIES ON PHOTON ACTIVATION ANALYSIS. PHOTONUCLEAR REACTION YIELD OF SEVERAL ALKALI AND ALKALINE EARTH ELEMENTS BY 18- TO 75-MeV BREMSSTRAHLUNG. Tsai, Hui-tuh; Harada, Hikaru (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 2, 139-44(Dec 1970). (In Japanese).

The reaction yields of the (γ,n), (γ,p), and (γ,pn) reactions were determined for rubidium, cesium, calcium, barium, and strontium in order to examine the energy dependence. Measurements of γ rays were made with a 300 MeV electron linear accelerator and a 1024 channel wave height analyzer of TMC Co. or a Ge(Li) semiconductor detector of ORTEC Co. The samples used were $BaCO_3$, $SrCO_3$, $CaCO_3$, RbCl, and CsCl. The yield of the photonuclear reaction of calcium was almost constant above 45 MeV and was about 30%. The yield of the ^{84}Sr (γ,p) ^{83}Rb reaction was 0.34 and 0.58, for 30 and 75 MeV, respectively. Reactions ^{130}Ba (γ, α p4n) ^{121}I and ^{134}Ba (γ, 3pn) ^{130}I did not occur at below 50 MeV. The yield of the reaction ^{130}Ba (γ, 3pn) ^{126}I was remarkably high. The yields of various reactions were shown as functions of the bremsstrahlung maximum energy. (Japan)

8584 RETARDATION OF RECOIL NUCLEI IN SOLID MEDIA BY THE METHOD OF NUCLEAR γ-RESONANCE SCATTERING. Kaipov, D. K.; Kosyak, Yu. G.; Smirin, L. N.; Shubnyi, Yu. K. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 1-5(Jul-Aug 1971). (In Russian).

The cross section of resonance scattering of 1430 keV γ quanta by ^{52}Cr nuclei was measured in metallic vanadium. The relative yield of nuclear resonance scattering for various V compounds was determined. The experimental results were used to determine the quantity $L \approx 3$ Å which characterizes the moderation process in metallic V, and also the dependence of the retardation of recoil nuclei on the crystalline structure of V compounds. (tr-auth)

8585 SEARCH FOR BRANCHING IN THE β^+ DECAY OF THE ^{42}Sc GROUND STATE. Burcham, W. E. (Univ., of Birmingham, Eng.); Murray, G.; Robinson, D. C.; Freeman, J. M.; Jenkin, J. G. Proc. Roy. Soc. Edinburgh, Sect. A; 70: 39-45(1972).

A search was made for branching to the 1.84 MeV state of ^{42}Ca in the ^{42}Sc ground state decay. This was found to be less than 0.02 per cent. The branching has a negligible effect on the calculation of the vector coupling constant G_V for the weak interaction from the ^{42}Sc decay. (auth)

8586 LIFETIME AND CONVERSION COEFFICIENT FOR THE 17 keV LEVEL IN ^{52}V. Boulter, J. F.; Prestwich, W. V. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A198: No. 1, 314-20(1972).

Using thermal neutron capture on natural vanadium targets, the lifetime and conversion coefficient for the 17 keV level in ^{52}V have been measured: $T_{1/2} = 1.08 \pm 0.22$ ns and $\alpha_{exp} = 4.6 \pm 1.8$. The conversion coefficient implies an $(89 \pm 8)\%$ M1 and $(11 \pm 8)\%$ E2 assignment for the 17 keV γ-ray. The experimental reduced M1 transition probability, $B(M1) = 0.66 \pm 0.30$ W.u., is compared with two theoretical calculations: one, a pure shell-model calculation assuming no configuration mixing, giving $B(M1) = 2.6$ W.u.; and the second, a calculation in which the static magnetic dipole moments of neighboring odd-proton and odd-neutron nuclei are taken as the base states, giving $B(M1) = 0.96$ W.u. Ten transitions in other nuclei are considered and a comparison of theoretical and experimental results yields a correlation coefficient $\rho = 0.943$ (for $N = 11$) using the empirical magnetic moments, and $\rho = 0.831$ using the Schmidt limits. Similar calculations are made for the ground state magnetic moments of the doubly odd nuclei and comparisons are made with the experimental moments where known. (auth)

8587 (^{3}He,n) REACTION OF EVEN (f,p) SHELL NUCLEI AT 18 AND 21 MeV. I. Evers, D. (Univ., Munich); Assmann, W.; Rudolph, K.; Skorka, S. J.; Sperr, P. Nucl. Phys.; A198: No. 1, 268-88(1972).

The (^{3}He,n) reaction on even Cr and Fe isotopes has been studied with the Munich time-of-flight facility at incident energies of 18 and 21 MeV. Angular distributions have been measured up to 55° and analyzed assuming a direct interaction mechanism. Good agreement is found between the experimental and DWBA angular distributions. Strongly excited 0^+ states are observed in ^{52,54,56}Fe and ^{56,58,60}Ni up to an excitation energy of about 10 MeV. In addition, some $L = 2$ transitions have been identified. The pairing vibrational model correctly describes the systematics of the ground state transitions and predicts the gross features of the excitation of 0^+ states. However, there are strong transitions to 0^+ states in ^{52,54,56}Fe and ^{56}Ni at an excitation energy of about 4 MeV which do not fit into the pairing vibrational model. (auth)

8588 STUDY OF THE ^{54}Cr(d,p)^{55}Cr AND ^{53}Cr(t,p)^{55}Cr REACTIONS. Macgregor, A. E.; Brown, G. (Univ. of Bradford, Eng.). Nucl. Phys.; A198: No. 1, 237-56(1972).

Differential cross sections have been measured for (d,p) and (t,p) reactions leading to levels of ^{55}Cr. Some spin assignments have been made using the values of the angular momentum transfer obtained from the angular distributions for both reactions; spin assignments for levels observed by $l_n = 1$ and $l_n = 3$ transitions in the (d,p) reaction have been made using empirical J-dependence. One level of $J = 7/2^-$, possibly two, has been located and it is suggested that it has been observed in the (d,p) reaction as a result of higher-order processes and not via particle-hole admixtures in the wave function of the target nucleus. It is shown that substantial admixtures of $2p_{3/2}$ and $1f_{7/2}$ neutron pairs exist in the ^{54}Cr ground state wave function and that these data are compatible with that of the (p,d) reaction. The level structure of ^{55}Cr is discussed and shown to be similar to that of ^{59}Ni. (auth)

8589 ANALYSIS OF THE ^{48}Ca(d,p)^{49}Ca REACTION FOR INCIDENT ENERGIES BELOW AND ABOVE THE COULOMB BARRIER. Rapaport, J. (Ohio Univ., Athens); Sperduto, A.; Salomaa, M. Contract AT(11-1)-3069. Nucl. Phys.; A197: No. 2, 337-51(1972).

The ^{48}Ca(d,p)^{49}Ca reaction has been studied at incident deuteron energies of 1.992, 2.485, and 2.925 MeV. Angular distributions for the ground state ($2p_{3/2}$) and first excited state ($2p_{1/2}$) were obtained at lab angles between 7.5° and 172.5°. Distorted-wave Born calculations were carried out using several sets of parameters, both in the zero-range local approximation and also introducing finite-range and non-local corrections. Those calculations were extended

up to 7.2 MeV bombarding energy to include data taken previously at this laboratory. (auth)

8590 STUDY OF ^{44,46,48,49}Ti ISOTOPES BY THE ^{46,48,50}Ti(p,t) REACTIONS. Kong-A-Siou, D. H.; Bruandet, J. F.; Longequeue, J. P.; Longequeue, N.; Vignon, B. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A197: No. 2, 568-82(1972). (In French).

The reactions ^{46,48,50}Ti(p,t) have been studied with 40 MeV protons. The angular distributions obtained were analyzed using zero-range DWBA calculations. Spin and parity assignments are given for levels up to about 10 MeV. In particular the levels of ^{46}Ti at 9.16 and 9.60 MeV could be the T = 2 analogs of the ground state and of the 0.44 MeV excited state in ^{46}Sc. Shell-model calculations with MSDI have been carried out for ^{44}Ti with a $(1f_{\frac{7}{2}}, 2p_{\frac{3}{2}})$ space. The calculated level scheme is compared to the results of other calculations and to the experimental data. (auth)

8591 ^{50}Ti(p,p'γ) ANGULAR-CORRELATION STUDY AT ISOBARIC ANALOG RESONANCES. Morgan, J. F.; Gearhart, N. L.; Hausman, H. J.; (and others) (Ohio State Univ., Columbus). Phys. Rev., C; 6: No. 6, 2126-32(Dec 1972).

Angular correlations were measured near several isobaric analog resonances observed in the ^{50}Ti(p,p'γ) reaction populating the ^{50}Ti 2^+ state at 1.555 MeV. In this manner the limitations on the J values of parent states in ^{51}Ti were obtained. Combining the present results with the l values previously obtained from ^{50}Ti(d,p) gives the following J^π values for the indicated parent states: 2.136 MeV, $\frac{5}{2}^-$ or $\frac{7}{2}^-$; 2.189 MeV, $\frac{3}{2}^-$; 2.896 MeV, $\frac{1}{2}^-$; 2.92 MeV, $\geq\frac{5}{2}$; and 3.164 MeV, $\frac{3}{2}^-$. The wave function of the 2.189-MeV state of ^{51}Ti is shown to have configurations other than the previously known $p_{\frac{3}{2}}$ neutron coupled to ^{50}Ti 2^+ component. (6 figures, 3 tables) (auth)

8592 NEUTRON DECAY FROM THE ^{49}Ca GROUND-STATE ANALOG IN ^{49}Sc. Elwyn, A. J. (Argonne National Lab., Ill.); Kuchnir, F. T.; Monahan, J. E.; (and others). Phys. Rev., C.; 6: No. 5, 1730-41(Nov 1972).

Relative angular distributions of neutrons from the ^{48}Ca(p,n)^{48}Sc reaction to four positive-parity states in ^{48}Sc were measured at 11 proton energies between 1.955 and 1.995 MeV. This energy interval encompasses a number of the components of the $\frac{3}{2}^-$ isobaric analog of the ^{49}Ca ground state in ^{49}Sc. The neutron decay of ^{49}Sc in the region of the two largest components is discussed in terms of a model of the (p,n) reaction in which the isospin-violating forces are assumed to manifest themselves through boundary-condition mixing only. The gross features of most of the data throughout this energy interval can be described in terms of two T=$\frac{3}{2}^-$ states and a number of $\frac{3}{2}^+$ and $\frac{5}{2}^+$ levels. The branching ratio for neutron decay to the various levels in ^{48}Sc suggests that the two major $\frac{3}{2}^-$ components have fairly simple but somewhat different shell-model configurations. (11 figures, 1 table) (auth)

8593 EXCITATION FUNCTIONS FOR HELION-INDUCED REACTIONS IN IRON. Fulmer, C. B.; Williams, I. R.; Palmer, W. C.; Kindred, G. (Oak Ridge National Lab., Tenn.). Phys. Rev., C.; 6: No. 5, 1720-30(Nov 1972).

Target foil stacks of iron were bombarded with beams of helions at incident energies ≤70 MeV. γ spectra of individual foils were measured and analyzed to obtain excitation functions for production of ^{56,57}Ni, ^{55,56,57,58}Co, ^{52,53}Fe, ^{52,54,56}Mn, and ^{51}Cr; for ^{53}Fe and ^{52}Mn, data were obtained for both ground and isomeric states. The yields of ^{56}Co and ^{57}Co are much larger than those of the respective Ni isobars. Recoil measurements (to determine momentum transfer to the target nucleus) were made at E_h = 41 and 51 MeV. These data show ^{57}Co to result principally from direct reactions. There is also evidence of a large contribution by direct reactions to the ^{56}Co yield. The excitation-function data are compared with predictions of compound-nucleus evaporation theory; these indicate compound-nucleus reactions to be the dominant contributor to the yields of ^{51}Cr, ^{52,54}Mn, ^{52,53}Fe, ^{55}Co, and ^{56,57}Ni. (10 figures, 2 tables) (auth)

8594 RADIATIVE ELECTRON CAPTURE IN ^{54}Mn AND ^{51}Cr. Koonin, S. E.; Persson, B. I. (California Inst. of Tech., Pasadena). Phys. Rev., C.; 6: No. 5, 1713-19(Nov 1972).

The continuous spectrum of photons accompanying the allowed electron-capture transition from ^{54}Mn to the first excited state in ^{54}Cr, as well as that from ^{51}Cr to the first excited state in ^{51}V, was measured in coincidence with the de-excitation γ rays. The end-point energy of the spectrum from ^{54}Mn was determined to be 518 ± 8 keV, which is somewhat at variance with the value 537 ± 4 keV calculated from accepted mass differences. The probability of radiative capture relative to ordinary nonradiative capture was determined to be $(15.4 \pm 0.8) \times 10^{-5}$ for ^{54}Mn in the energy range 82 to 515 keV. This is considerably larger than the value 10.9×10^{-5} predicted by the relativistic theory of Martin and Glauber. The shape of the photon spectrum is, nevertheless, in excellent agreement with the theoretical prediction. For ^{51}Cr the end point was determined to be 424 ± 16 keV, in excellent agreement with accepted mass differences. The relative rate of radiative capture with a photon energy greater than 130 keV was determined to be $(7.2 \pm 0.4) \times 10^{-5}$, in disagreement with the theoretical value of 5.5×10^{-5}, while the spectrum shape agrees excellently with the theory. A survey of the experimental verification of the Martin and Glauber theory is presented. (6 figures, 1 table) (auth)

8595 STUDY OF THE (p,2p) REACTION AT 17 MeV IN THE Ni REGION. Fink, C. L.; Cohen, B. L. (Univ. of Pittsburgh). Phys. Rev., C.; 6: No. 5, 1673-85(Nov 1972).

Differential (p,2p) cross sections to various final states were measured for eight different nuclei in the Ni region at an incident energy of 17 MeV, for the case of protons emerging at an angle of ±90°. The coincident proton energy spectrum showed that the (p,2p) reaction consists of a (p,p') reaction followed by the boiloff of a proton. An attempt is made to explain the observed cross sections by assuming that the (p,p') reaction is a compound process and that the subsequent proton boiloff is given by statistical theory. In this model, the relative probability for populating various final states depends on the spin cutoff parameter of the decaying compound nucleus, as well as the total radiation width. It is found that it is also necessary to take into account that the proton widths obey a Porter–Thomas distribution in order to reproduce the observed proton–γ competition near threshold. The measured total radiation width, obtained by using typical values of the spin cutoff parameter, is approximately a factor of 5 below the average values obtained from neutron-capture work and a factor of 2 below the value obtained from an extrapolation of the giant dipole resonance. A direct study of the spin cutoff parameter was possible only for ^{54}Fe. For the other even–even nuclei, the excited states are weak or obscured by contaminants, while for the odd–even targets, the (p,p') spectrum indicates that a significant portion of the (p,p') reaction is due to a direct process. The ^{54}Fe cross sections are best fit by increasing the value of the spin cutoff parameter to a value above that obtained by assuming a rigid-body value for the moment of inertia. (11 figures, 3 tables) (auth)

8596 RENORMALIZED BRUECKNER–HARTREE–FOCK CALCULATIONS USING DIFFERENT PRESCRIPTIONS FOR THE INTERMEDIATE-STATE SPECTRUM. Davies, K. T. R. (Oak Ridge National Lab., Tenn.); McCarthy, R. J.; Sauer, P. U. Phys. Rev., C.; 6: No. 5, 1461-7(Nov 1972).

Calculations of the spherical nuclei ^{16}O, ^{40}Ca, and ^{208}Pb are presented for G matrices which differ in the definition of the particle spectrum. Detailed comparisons are made using pure harmonic-oscillator, shifted-oscillator, and QTQ intermediate-state spectra. Attention is particularly focused on the saturation properties of the various G matrices. The QTQ prescription seems to give somewhat better saturation properties than the oscillator prescriptions. A comparison is made in ^{40}Ca between the QTQ results and some results obtained by Negele. A study is also made of the importance of the relative partial waves not defined in the Reid soft-core potential. (6 figures, 4 tables) (auth)

8597 LEVEL STRUCTURE OF ^{48}Cr AND ^{68}Ge FROM THE (p,t) REACTION AT E_p = 27 MeV. Shepard, J. R.; Graetzer, R.; Kraushaar, J. J. (Univ. of Colorado, Boulder). Nucl. Phys.; A197: No. 1, 17-32(1972).

The (p,t) reaction has been used at 27 MeV to study the level structure of the neutron-deficient nuclei ^{48}Cr and ^{68}Ge. Angular distributions were obtained for the tritons leading to eight states in ^{48}Cr and twelve states in ^{68}Ge. With the help of DWBA calculations a number of spin and parity assignments were made. The level structure of ^{48}Cr differs appreciably from that predicted by an $f_{\frac{7}{2}}$ shell-model calculation. The low-lying 0^+ state in ^{72}Ge and ^{70}Ge is not in evidence in ^{68}Ge. The strengths of the transitions observed for ^{68}Ge levels are considerably greater than that predicted by a zero-range DWBA calculation with simple shell-model configurations for the transferred neutrons. (auth)

8598 VECTOR ANALYSING POWER AND CROSS SECTION FOR (d,p) REACTIONS ON ^{40}Ca, ^{46}Ti, ^{48}Ti, ^{50}Ti, ^{52}Cr, AND ^{54}Fe. Kocher, D. C.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; A196: No. 2, 225-68(1972).

Angular distributions of the vector analyzing power and the absolute cross section were measured for (d,p) reactions on ^{40}Ca, ^{46}Ti, ^{48}Ti, ^{50}Ti, ^{52}Cr, and ^{54}Fe at deuteron energies of 10 or 11 MeV. The observed j-dependence of the vector analyzing power allowed unambiguous spin assignments for about 15 states in each residual nucleus. Distorted-wave Born approximation calculations employing deuteron and proton optical-model parameters obtained from analyses of elastic cross sections and polariza-

tions qualitatively reproduce the measured angular distributions. The energies of the $2p_{\frac{1}{2}}$, $2p_{\frac{3}{2}}$, $1f_{\frac{5}{2}}$, and $1f_{\frac{7}{2}}$ neutron single-particle states in the residual nuclei were determined. The strength of the nuclear spin-orbit interaction calculated from the splitting of the p-states is in good agreement with the strength obtained from analyses of nucleon-nucleus elastic scattering. (auth)

8599 LIFETIME AND ANGULAR-CORRELATION MEASUREMENTS IN ^{47}Ti. Weaver, J. J. (Nuclear Physics Lab., Oxford); Grace, M. A.; Start, D. F. H.; (and others). Nucl. Phys.; A196: No. 2, 269-85(1972).

Mean lifetimes of levels below 2.42 MeV in ^{47}Ti were determined with the ^{47}Ti(p,p'γ)^{47}Ti reaction using the Doppler-shift attenuation method. The results are: 1253 keV, 210 ± 20 fs; 1445 keV, $1.5^{+0.5}_{-0.3}$ ps; 1550 keV, $2.25^{+0.90}_{-0.50}$ ps; 1795 keV, >2 ps; 1825 keV, >2 ps; 2164 keV, 31 ± 8 fs; 2168 keV, 25 ± 6 fs; 2260 keV, $1.2^{+0.5}_{-0.3}$ ps; 2297 keV, 11 ± 7 fs; 2365 keV, >1.5 ps; 2408 keV, 31^{+13}_{-10} fs; 2416 keV; >2 ps. The ^{48}Ti($\tau,\alpha\gamma$)^{47}Ti reaction was used to measure $\alpha-\gamma$ angular correlations. Decay modes, branching ratios and multipole mixing ratios were determined. Unambiguous spin assignments were obtained for the 1253 keV level ($^{9}/_{2}^{-}$) and the 1445 keV level ($^{11}/_{2}^{-}$) and the number of possible spin values was restricted for some of the higher levels. The energies and spins of the four lowest levels as well as the B(M1) and B(E2) values of their γ-decay are generally in good agreement with calculations based on the rotational model and suggest that these levels are strongly collective. (auth)

8600 TWO-STEP MECHANISMS IN THE REACTION ^{48}Ca(τ,t)^{48}Sc. De Takacsy, N. B. (McGill Univ., Montreal). Phys. Lett.; 42B: No. 1, 1-4(13 Nov 1972).

The differential cross sections for the ^{48}Ca(τ,t)^{48}Sc reaction were calculated including both the one-step charge exchange and the twice single-particle-transfer mechanisms. Both α-particle and deuteron intermediate states are included in the two-step amplitudes. It is concluded that the two-step contribution with a deuteron intermediate state is quite weak in the forward directions but is characterized by a flat angular distribution which makes it important at back angles. (auth)

8601 COMPETITION BETWEEN THREE VALENCE-SHELL NEUTRONS AND THE QUADRUPOLE VIBRATION IN ^{57}Fe. Paar, V. (Univ. of Copenhagen). Phys. Lett.; 42B: No. 1, 8-12(13 Nov 1972).

The quasi-rotational features of ^{57}Fe are reproduced by coupling a three-neutron valence-shell cluster to the low-frequency quadrupole vibration (Alaga model). In the spherical basis the essential role is played by the explicit appearance of seniority-three states (with broken and promoted pairs) in the neutron valence shell. (auth)

8602 INTERFERENCE BETWEEN COULOMB AND NUCLEAR EXCITATION IN THE INELASTIC SCATTERING OF ^{6}Li IONS. Chuev, V. I.; Glukhov, Yu. A.; Manko, V. I.; (and others) (Inst. of Atomic Energy, Moscow). Phys. Lett.; 42B: No. 1, 63-5(13 Nov 1972).

Angular distributions were measured for inelastic and elastic scattering of ^{6}Li ions by ^{58}Ni and ^{120}Sn. Strong interference between Coulomb and nuclear excitation in inelastic scattering was observed. (auth)

8603 COMPARISON OF (τ,n) GROUND-STATE TRANSITIONS IN THE (fp) SHELL WITH PREDICTIONS OF THE PAIRING VIBRATIONAL MODEL. Alford, W. P.; Lindgren, R. A.; Elmore, D. (Univ. of Rochester, N. Y.). Phys. Lett.; 42B: No. 1, 60-2 (13 Nov 1972).

The (^{3}He,n) reaction was studied at 15 MeV for all stable even-even target nuclei from ^{46}Ti to ^{64}Ni. Relative strengths obtained for the L = 0 ground-state transitions are compared with the predictions of the pairing vibrational model with isospin. The trend of the deviations from predicted strengths differs from that reported in analogous studies of the (t,p) two-neutron transfers in this mass region. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 8295, 8513, 8514, 8530, 8536, 8560, 8579, 8580, 8583, 8595, 8603, 8624, 8628, and 8718.

8604 (BNL-tr-506) DE-EXCITATION OF ^{87}Sr AND ^{93}Zr FOLLOWING THE CAPTURE OF THERMAL NEUTRONS. Groshev, L. V.; Govor, L. I.; Demidov, A. M. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz.; 15: No. 4, 625-8(1972). 7p. Dep. NTIS.

The γ-ray spectra from the radiative capture of thermal neutrons in ^{86}Sr, ^{90}Zr, and ^{92}Zr were measured with use of a thermal neutron beam extracted from the IRT-M reactor. The spectra of ^{87}Sr and ^{91}Zr were obtained in the ranges 50 to 1500 keV and 4.2 to 9.0 MeV, and those of ^{93}Zr, in the ranges 50 to 1500 keV and 1.4 to 8.0 MeV. A detector ~0.5 cm^3 in volume was used in the low energy region, and one ~5 cm^3 in volume in the high energy region. The resolution of the spectrometer was between 2 and 12 keV in the energy range from 50 keV to 9 MeV. (auth)

8605 (ORNL-tr-2635) ANGULAR DISTRIBUTION OF NEUTRONS PRODUCED IN BOMBARDMENT OF Ge, Mo, Ag, AND Pr TARGETS BY HEAVY C, O, Ne, AND Ar IONS. Il'inov, A. S.; Karamyan, S. A.; Nguyen Tak An; Sharifov, K. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Translated for Oak Ridge National Lab., Tenn., from report JINR-P7-6316. 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 26: 32355. (J.W.R.)

8606 LEVEL STRUCTURE OF ^{87}Zr. Turcotte, R.; Iafigliola, R.; Moore, R. B.; Lee, J. K. P. (McGill Univ., Montreal). Nucl. Phys.; A198: No. 1, 67-72(1972).

The level structure of ^{87}Zr has been studied by observing the γ-rays following the decay of ^{87g}Nb, ^{87m}Nb and ^{87m}Zr and their respective half-lives were measured to be 3.9 ± 0.2 min, 2.6 ± 0.1 min and 14.0 ± 0.2 s. A Ge(Li)-Ge(Li) coincidence experiment was performed and the decay schemes with spin and parity assignments for the levels in ^{87}Zr were proposed. (auth)

8607 MAGNETIC MOMENTS, LIFETIMES, AND γ-DECAY OF THE LOWEST 6$^-$ STATES IN ^{64}Cu AND ^{66}Cu. Bleck, J.; Butt, R.; Lindenberger, K. H.; Ribbe, W.; Zeitz, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys.; A197: No. 2, 620-30(1972).

The doubly-odd nuclei ^{64}Cu and ^{66}Cu are investigated by means of γ-ray spectroscopy following ^{63,65}Cu(d,p) with pulsed 6.5 MeV deuterons. The energies of about 80 transitions between 50 and 1450 keV are redetermined. Two isomeric levels are discovered in ^{64}Cu (1594 keV, τ = 29.5 ± 1.0 nsec) and in ^{66}Cu (1154 keV, τ = 860 ± 30 nsec). By time-differential perturbed angular distribution measurements on all delayed γ-rays a strong similarity between parts of the level schemes of ^{64}Cu and ^{66}Cu becomes apparent. Both isomers have $J^{\pi} = 6^-$ and decay through a cascade 6^-(M2) 4^+(M1) 3^+(M1) 2^+(M1) 1^+ with only a weak E2 admixture, and without branching to levels outside this quartet. Both M2 transitions are hindered by a factor of about 30 which is usual in this mass region. The magnetic moments of both 6$^-$ states are measured to be +1.06 ± 0.03 n.m. and +1.038 ± 0.003 n.m. for ^{64}Cu and ^{66}Cu respectively. They are well explained by the additive coupling of a $^{3}/_{2}^{-}$ proton moment and a $^{9}/_{2}^{+}$ neutron moment taken from neighboring odd-even and even-odd nuclei. (auth)

8608 BETA-SPECTRA SHAPE FACTORS IN THE DECAY OF ^{140}La AND ^{72}Ga. Connor, R. D.; Goldman, T. J.; Fairweather, I. L. (Univ. of Manitoba, Winnipeg). Proc. Roy. Soc. Edinburgh, Sect. A; 70: 67-74(1972).

The shape factors of the partial β-spectra of highest end-point energy in the decay of ^{72}Ga and ^{140}La have been calculated and compared with the only previously reported determination of these quantities. For both isotopes the shape factor is consonant with the view that the B_{ij} matrix element controls the decay. Shape factor analysis alone is insufficient to determine the cause of the predominance of a particular matrix element. (auth)

8609 SPIN DISTRIBUTION OF THE NUCLEAR LEVEL DENSITY NEAR A = 60. Lu, C. C.; Vaz, L. C.; Huizenga, J. R. (Univ. of Rochester, NY). Nucl. Phys.; A197: No. 2, 321-36(1972).

The spin dependence of the nuclear level density of ^{56}Fe, ^{59}Co, ^{60}Ni, ^{62}Ni, ^{63}Cu and ^{65}Cu has been determined by measurement of particles from the ^{56}Fe(α,α')^{56}Fe, ^{59}Co(α,α')^{59}Co, ^{60}Ni(α,α')^{60}Ni, ^{62}Ni(α,α')^{62}Ni, ^{63}Cu(α,α')^{63}Cu, ^{60}Ni(α,p)^{63}Cu, ^{62}Ni(α,p)^{65}Cu, ^{63}Cu(p,α)^{60}Ni and ^{65}Cu(p,α)^{62}Ni reactions. The experiments are analyzed with the exact statistical theory of nuclear reactions including explicitly the angular momentum. The spin cut-off factor σ was determined for each of the above nuclei investigated in the (α,α') and (α,p) reactions. These values of σ are consistent with the theoretical values based on an equidistant single-particle level scheme for Fermi particles and a rigid-body moment of inertia with radius parameter r_0 = 1.2 fm. The measurements on (α,α') reactions give a more reliable value of σ than the reactions where the entrance or the exit particle is a nucleon. The experimental values of σ are also compared with values calculated for three theoretical models with non-periodic single-particle levels with and without the pairing interaction included. When the pairing interaction is included, excellent agreement is obtained between the microscopic theory and experiment. (auth)

8610 ENERGY LEVELS IN ^{85}Rb AND ^{87}Rb FROM THE (n,n'γ) REACTION. Torti, R. P.; Cottles, V. M.; Dave, V. R.; Nelson, J. A.; Wilenzick, R. M. (Tulane Univ., New Orleans). Phys. Rev., C.; 6: No. 5, 1686-90(Nov 1972).

High-resolution measurements of the γ rays following neutron inelastic scattering by ^{85}Rb and ^{87}Rb were made for neutron energies between 0.3 and 2.2 MeV. An enriched ^{85}Rb scatterer was used for isotopic identification. Eight new levels were assigned in ^{85}Rb below 1445 keV excitation, and two new levels below 1739 keV were observed in ^{87}Rb. Branching ratios and differential γ-ray production cross sections at 95° were also determined. (4 figures, 1 table) (auth)

8611 (^{3}He,n) REACTION AT 25 MeV. Greenfield, M. B. (Univ. of Tennessee, Knoxville); Bingham, C. R.; Newman, E.; Saltmarsh, M. J. Phys. Rev., C.; 6: No. 5, 1756-69(Nov 1972).

The (^{3}He,n) reaction was studied on targets of ^{12}C, ^{27}Al, ^{28}Si, and ^{58,60,62}Ni at an incident energy of 25 MeV. The observed resolution of the neutron time-of-flight spectrometer used in this work was about 1%. Differential cross sections were obtained for the resolvable final states over the angular range of 0 to 40°(L). The angular distributions were compared with the predictions of a simple, one-step, two-nucleon-transfer model. In this formalism the diproton stripped from ^{3}He is transferred to the target retaining its $^1S_0$ relative motion. The shapes of the angular distributions were unique for a given l transfer and were, in most cases, generally reproduced by the calculations. For 0^+ targets the J^π of many final states could be assigned. Comparison of experimental with theoretical relative magnitudes permitted assignment of dominant shell-model configurations. To first approximation the relative transition strengths to final states in ^{14}O, ^{30}S, and ^{60}Zn were consistent with the assumption of two particles coupled to an effectively "closed core." (12 figures, 6 tables) (auth)

8612 ELASTIC SCATTERING OF ^{16}O BY ^{56}Fe, ^{70} ^{74}Ge, AND ^{90}Zr. Obst, A. W.; McShan, D. L.; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev., C.; 6: No. 5, 1814-21(Nov 1972).

The elastic scattering of ^{16}O by ^{56}Fe, ^{70}Ge, ^{74}Ge, and ^{90}Zr was studied in the vicinity of the Coulomb barrier for the purpose of extracting optical-model parameters and barrier heights. Angular distributions were measured from 30 to 170° in the lab in 10° steps and in the bombarding energy range from 30 to 60 MeV in 2-MeV steps. No discrete ambiguities in the real potentials were found, probably due to the large imaginary potentials. Barrier heights determined with the optical-model parameters were found to be consistent with Greiner's calculated barrier heights and 10 to 20% lower than the ordinary Coulomb barrier $Z_1Z_2e^2/1.35(A_1^{1/3} + A_2^{1/3})$. (13 figures, 1 table) (auth)

8613 GAMMA DECAY OF STATES OF ^{88}Y EXCITED BY THE ^{88}Sr(p,n)^{88}Y REACTION. Gabbard, F.; Chenevert, Gary; Sekharan, K. K. (Univ. of Kentucky, Lexington). Phys. Rev., C; 6: No. 6, 2167-76(Dec 1972).

The ^{88}Sr(p,n)^{88}Y and ^{88}Sr(p,nγ)^{88}Y reactions were used to study the excited states of ^{88}Y up to an excitation energy of 1832 keV. Determinations of the excitation energies of 18 levels to an accuracy of ±1 and ±2 keV, for levels with excitation energies less than and greater than 800 keV, respectively, were made. Angular distributions of five γ rays de-exciting states at 232, 393, 706, and 766 keV were measured and analyzed according to the statistical-model theory. This analysis confirms assignments of J^π values of 5^-, 1^+, 2^-, and 0^+ to these respective states. Of particular interest is the 2^- level at 706 keV. The intensities of neutrons from the ^{88}Sr(p,n)^{88}Y reaction exciting levels up to 1832 keV were compared with statistical-model calculations of the neutron yields to the respective states for particular assumed spin values. Consistent spin-parity assignments are given for many of the levels observed. (9 figures, 2 tables) (auth)

8614 STUDY OF THE GAMMA RAYS FROM THERMAL-NEUTRON CAPTURE IN ^{64}Ni. Cochavi, S.; Kane, W. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C.; 6: No. 5, 1650-7(Nov 1972).

The γ radiation emitted following thermal-neutron capture by ^{64}Ni was studied in singles and coincidence with 15-, 30-, and 40-cm^3 Ge(Li) detectors. γ rays of the following energies (in keV) and relative intensities (in parentheses) were assigned to ^{65}Ni: 63.6 (13), 247.1 (0.5), 310.5 (23.0), 382.0 (0.7), 628.8 (7.3), 692.2 (1.5), [726 (0.2)], 1107.4 (3.8), [1418 (0.2)], 2083.8 (0.6), 2147.2 (0.3), 3950.2 (1.1), 4679.5 (3.8), 5405.2 (9.2), 5787.1 (18), 6034.0 (70). All these transitions were incorporated in a level scheme for the ^{65}Ni nucleus with levels at the following energies: 63.6 ± 0.3, 310.5 ± 0.2, 692.3 ± 0.3, 1417.9 ± 0.4, and 2147.2 ± 0.5 keV. A lower lifetime limit of $\tau > 3$ μsec was measured and a conversion coefficient of $\alpha \sim 5$, deduced for the 63.5-keV state. These are consistent with the $\frac{1}{2}^-$ assignment made in a study of the ^{64}Ni(d,p)^{65}Ni reaction. A $\frac{3}{2}^-$ assignment is suggested for the 310.5-keV state by the branching ratio to the 63.6-keV level and the ground state. The neutron separation energy is 6097.6 ± 0.6 keV for ^{65}Ni and 6837.6 ± 1.0 keV for ^{63}Ni. The strengths of the five observed primary transitions and corresponding proton groups in the (d,p) reaction were compared, and a correlation coefficient of 0.8 was obtained. The γ decay of the ^{65}Ni ground state was also investigated. (5 figures, 2 tables) (auth)

8615 LEVELS OF ^{64}Co POPULATED BY THE ^{64}Ni(t,τ) REACTION. Flynn, E. R.; Garrett, J. D. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett.; 42B: No. 1, 49-50(13 Nov 1972).

The ^{64}(t,^{3}He) reaction was used to measure the mass excess of the ^{64}Co ground state, −59 803 ± 20 keV. The mass excess was previously uncertain by ±0.5 MeV. (auth)

8616 STUDY OF THE ^{88,86}Sr(d,α)^{86,84}Rb REACTIONS. Bucurescu, D. (Inst. of Atomic Physics, Bucharest); Ivascu, M.; Popescu, D.; Titirici, M.; Spilling, P. Nucl. Phys.; A197: No. 1, 121-8(1972).

The (d,α) reaction has been performed on ^{88}Sr and ^{86}Sr at 11.62 MeV. Twelve excited states in ^{86}Rb and ten excited states in ^{84}Rb have been observed, and angular distributions have been measured for most of them. A zero-range, local DWBA analysis provides L-values and J^π limits. (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 7993, 8513, 8514, 8530, 8539, 8546, 8553, 8579, 8583, 8602, 8604, 8605, 8608, 8612, 8653–8655, and 8730.

8617 (JINR-E6-6620) NEW ISOMERIC STATE IN ^{134}Pr AND EXCITED STATES OF ^{134}Ce. Arlt, R.; Beyer, G.; Fominykh, V. I.; Herrmann, E.; Jasinski, A.; Ortlepp, H. G.; Shtrusnyi, Kh.; Tyrroff, Kh.; Usmanova, Z. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 18p. Dep. NTIS (U. S. Sales Only).

Radioactive sources of ^{134}Pr and ^{134}Nd in equilibrium with ^{134}Pr daughter obtained by spallation reaction have been studied with Ge(Li) detectors. A new isomeric state has been found in ^{134}Pr. Gamma–gamma coincidences have been measured using two 25 cm^3 Ge(Li) detectors. On the basis of gamma intensities, energy sums, and coincidence information decay schemes are proposed for the isomeric and ground state of ^{134}Pr. (auth)

8618 (JINR-P6-6634) $\mathcal{P}$ FORBIDDEN MI TRANSITION IN ^{132}La NUCLEUS. Morozov, V. A.; Muminov, T. M.; Fuya, Kh.; Khalikulov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

The life-time of the 182-keV level of ^{132}La was measured to be $T_{1/2}$ = (0.83 ± 0.11) ns. Conclusions are made on the structure of the ^{132}La levels with energies 155 and 182 keV. (auth)

8619 (LBL-1247) TRANSFER REACTIONS IN THE Zr–Mo REGION INDUCED BY α PARTICLES AND HEAVY IONS. Zisman, M. S. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug. 1972. Contract W-7405-eng-48. 262p. Dep. NTIS. Thesis.

The (α,d) and (α,t) reactions on targets of ^{90,91,92,94}Zr and ^{92}Mo have been investigated with 50 and 65 MeV α-particle beams from the Berkeley 88-inch cyclotron. High-spin proton states observed in the (α,t) reaction, based on comparisons with (^{3}He,d) data on the same targets, include: ^{91}Nb [2.39, 2.53, 2.61, 2.77, 2.90, 3.01, 4.18, 4.77, 4.89, and (5.14) MeV], ^{93}Tc [0.68, (3.58), 3.91, 4.37, (4.47), (4.67), 4.77, 4.90, 6.01 (multiplet), 6.17, and 6.44 MeV], ^{92}Nb [≈5 MeV multiplet], ^{93}Nb [1.08, 1.29, and ≈4.5 MeV], and ^{95}Nb [1.27, 1.65, (2.10), and ≈4.5 MeV]. A difference in Q-values for the ^{90}Zr(α,t)^{91}Nb and ^{91}Zr(α,t)^{92}Nb reactions of 680 ± 25 keV yields a new Q-value, −14.643 ± 0.027 MeV, for the ^{90}Zr(α,t) reaction. This corresponds to a change in the ^{91}Nb mass excess of +98 keV, in agreement with other recent determinations of this quantity. Two groups of strongly excited states appear in the (α,d) data. Members of the lower group [^{92}Nb (g.s), ^{94}Nb (0.08 MeV), and ^{96}Nb (0.23 MeV)] have been previously identified as $(\pi g_{9/2}, \nu d_{5/2})_{7+}$ states. From the ^{92}Mo(α,d)^{94}Tc results, the ^{94}Tc ground state can also be assigned $J^\pi = 7^+$. The higher levels [^{92}Nb (2.58 MeV), ^{94}Nb (2.42 MeV), ^{96}Nb (2.38 MeV), and ^{94}Tc (2.68 MeV)] are believed to be either $(\pi g_{9/2}, \nu h_{11/2})_{10-}$ or $(\pi g_{9/2}, \nu g_{7/2})_{8+}$ states, based on the results of shell model matrix element calculations and the (α,d) structure factors of Glendenning. As an example of the systematics of the (α,d) reaction, results from the ^{14}N(α,d)^{16}O reaction at 40 MeV are also included here. Accurate excitation energies and widths for the previously observed [^{14}N (1$^+$) + $(d_{5/2})^2_{5+}$] triplet in ^{16}O have

been determined to be: 14.40 ± 0.03 MeV ($\Gamma_{c.m.}$ = 30 ± 30 keV), 14.82 ± 0.03 MeV ($\Gamma_{c.m.}$ = 69 ± 30 keV), and 16.24 ± 0.04 MeV ($\Gamma_{c.m.}$ = 125 ± 50 keV). The (^{16}O,^{15}N) and (^{16}O,^{15}O) reactions on targets of ^{90,91,94}Zr, ^{92}Mo, and ^{93}Nb were also investigated with a 104 MeV ^{16}O (4+) beam from the Berkeley 88-inch cyclotron. Outgoing heavy ions were detected in the focal plane of a magnetic spectrometer with a Borkowski–Kopp type position sensitive proportional counter backed by a plastic scintillator and phototube. The (^{16}O, ^{15}N) and (^{16}O, ^{15}O) data indicate a preference for high angular momentum transfer similar to (but less pronounced than) that shown by the (α,t) and (α,^{3}He) reactions on the same targets. Contrary to a suggestion by Nickles et al., no strong evidence for a multi-step excitation of core-excited states is apparent from the present data. (auth)

8620 STUDY OF PHOTONUCLEAR SPALLATION BY THE METHOD OF RESIDUAL NUCLEI. Morita, I.; Kato, T. (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 1, 109-14(Sep 1971). (In Japanese).

The photonuclear spallation of ^{141}Pr with bremsstrahlung of 250 MeV was performed to investigate the reaction mechanism with the high energy photon. Target material of Pr_2O_3 or $Pr(NO_3)_3$ was wrapped in aluminum foils and irradiated with 250-MeV bremsstrahlung converted from the electron beam of an electron linear accelerator. Chemical separation of the irradiated material was performed immediately after the irradiation according to the process shown in a figure. Cesium, iodine, tellurium and antimony were separated from the target. Identification of the nuclei was performed by measuring the gamma spectra with a Ge(Li) detector and the decay curve. Yield was obtained from the gamma spectra. Corrections were made for the transfer of atomic number due to the decay of the time interval between the reaction and the beginning of the chemical separation. Yield curves were obtained for various nuclei of cesium, iodine, tellurium and antimony. The maximum of the curves shows an exponential decrease with the atomic number. A relation between the yield and the mass number difference from the stable line was obtained and shown in a figure. It was concluded that the reaction of ^{141}Pr caused by the 250-MeV bremsstrahlung was a spallation type reaction explained by a two-step model. (Japan)

8621 COULOMB (d,p) STRIPPING TO STATES IN $^{117\ 123\ 125}$Sn. Carson, P. L.; McIntyre, L. C. Jr. (Univ. of Arizona, Tucson). Nucl. Phys.; A198: No. 1, 289-313(1972).

Angular distributions were measured for the reactions ^{116}Sn(d,p) ^{117}Sn, ^{122}Sn(d,p)^{123}Sn, and ^{124}Sn(d,p)^{125}Sn at several incident deuteron energies between 4.55 and 5.55 MeV. Below 5.2 MeV excitation energy, 52 levels are observed in ^{117}Sn, 49 in ^{123}Sn, and 49 in ^{125}Sn. Many of the upper levels in all three nuclei are previously unreported, as is the 0.859 MeV level in ^{125}Sn. Spectroscopic factors and reduced widths for many states of interest were extracted using the DWBA theory. Comparison with spectroscopic factors from other experiments and with results from pairing theory calculations reveals general agreement, although not within the accuracy expected for the present results. (auth)

8622 COINCIDENCE STUDIES OF ^{144}Pr WITH AN X-RAY DETECTOR. Mishra, R. K.; Richardson, H. O. W.; Thomas, R. N.; Thomas, R. V. (Bedford Coll., London). Proc. Roy. Soc. Edinburgh, Sect. A; 70: 245-50(1972).

Some recent advances in coincidence techniques are applied in an attempt to set upper limits to the intensities of some unconfirmed γ rays of ^{144}Pr. The upper three lines start from an unconfirmed level at 166 keV. The three lower lines are transitions between well established levels and have low intensities because they are in competition with stronger γ rays. (L.T.W.)

8623 SPIN OF THE 1643 keV STATE AND MULTIPOLE MIXING RATIOS OF γ-TRANSITIONS IN ^{134}Ba. Behar, M.; Steffen, R. M.; Telesco, C. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; A192: No. 1, 218-24(1972).

Directional correlations of the ^{134}Ba γ rays following the β-decay of ^{134}Cs were measured using two high-resolution 30 cm^3 coaxial Ge(Li) detectors. Particular attention was paid to the various corrections that must be applied in measuring γ–γ directional correlations in complex decays. It was clearly established that the spin-parity of the 1634 keV excited state of ^{134}Ba is 3$^+$. The multipole mixing ratios (in the Krane–Steffen definition) of the ^{134}Ba γ rays are (energies in keV): $|\delta(475)|$ = >18, $\delta(563)$ = –7.4 ± 0.9, $\delta(569)$ = +0.29 ± 0.02, $\delta(1038)$ = 1.85 ± 0.15. (auth)

8624 ^{91}Zr(p,t) REACTION AND THE LEVEL STRUCTURE OF ^{89}Zr. Ball, J. B. (Oak Ridge National Lab., TN). Phys. Rev., C; 6: No. 6, 2139-47(Dec 1972).

The ^{91}Zr(p,t) reaction was studied at a proton energy of 31 MeV. Tritons were detected in a magnetic spectrograph yielding a resolution of 18 keV. Angular distributions for levels up to 2.75 MeV of excitation in ^{89}Zr are compared to two-nucleon-transfer distorted-wave Born-approximation calculations and analyzed in terms of the mixed L transfers allowed from a nonzero-spin target. Two types of neutron configurations are observed to be populated in ^{89}Zr by this reaction: single-hole states and one-particle–two-hole states. (9 figures, 2 tables) (auth)

8625 DECAY OF ^{125}Cs, ^{127}Cs, AND ^{129}Cs. Jha, S. (Univ. of Cincinnati); Peek, N. F.; Knox, W. J.; May, E. C. Phys. Rev., C; 6: No. 6, 2193-2200(Dec 1972).

Neutron-deficient isotopes of cesium (^{129}Cs, ^{127}Cs, and ^{125}Cs) were produced by the α-particle bombardment of natural iodine. γ-ray energies and intensities were measured with Ge(Li) detectors. In the decay of 32-h ^{129}Cs, among others, 372- and 582-keV γ rays were detected. In the decay of 6.2-h ^{127}Cs, new γ rays were detected, and new levels at 1430, 1805, and 1829 keV are proposed. In the decay of 45-min ^{125}Cs, the following levels in ^{125}Xe (percentage feeding in parentheses) are proposed: ground state (54%), 112 keV (2%), 526 keV (30%), 540 keV (4%), 712 keV (6%), 1311 keV (0.33%), 1326 keV (0.43%), 1579 keV (0.5%), 1698 keV (0.7%), 2154 keV (0.2%), 2523 keV (0.2%), and 2545 keV (0.1%). These decay schemes show that the β decay of these cesium isotopes takes place preferentially to the excited states in the daughter xenon isotopes. (8 figures, 3 tables) (auth)

8626 LARGE E1 AND M1 RADIATIVE WIDTHS IN NUCLEI NEAR CLOSED SHELLS. Wolf, A.; Moreh, R.; Nof, A.; Shahal, O.; Tenenbaum, J. (Nuclear Research Center, Beer-Sheba, Israel). Phys. Rev., C; 6: No. 6, 2276-81(Dec 1972).

The radiative widths, spins, and parities of ten levels photoexcited by the (γ,γ') reaction at excitation around 7 MeV in ^{139}La, ^{140}Ce, ^{141}Pr, ^{142}Nd, ^{144}Nd, ^{205}Tl, and ^{209}Bi were measured. The γ beam was produced by thermal-neutron capture in titanium, iron, cobalt, and copper. The spins of the resonance levels were obtained by angular-distribution measurements, and the parities were determined by using a Compton polarimeter. These levels together with other resonance levels in N ~ 82 and N ~ 126 nuclei are discussed with regard to a possible connection to a giant M1 resonance. (4 figures, 2 tables) (auth)

8627 ^{136}Xe(p,p')^{136}Xe AND ^{136}Xe(p,d)^{135}Xe REACTIONS. Sen, S.; Riley, P. J.; Udagawa, T. (Univ. of Texas, Austin). Phys. Rev., C; 6: No. 6, 2201-10(Dec 1972).

Low-lying states of ^{136}Xe with excitation energies up to 3.3 MeV were investigated via inelastic scattering of 13.982-MeV protons. Spin, parity, and deformation parameters were extracted for 13 excited states through distorted-wave Born-approximation (DWBA) analysis using a collective-model form factor. The results obtained indicate that ^{136}Xe is not a typical vibrational nucleus. A microscopic calculation for the level spectrum and the inelastic form factor, based on the quasi-particle random-phase approximation, was performed. DWBA angular distributions were calculated using a microscopic form factor. The level spectrum and the absolute magnitudes of the cross sections for most of the 4$^+$, 6$^+$, and 3$^-$ observed states were reasonably well reproduced through these calculations. For the 2$^+$ states, however, the predicted level density and the distribution of the inelastic strengths disagreed, with the observed data. In addition, three deuteron groups leading to states of ^{135}Xe were observed. The orbital-angular-momentum-transfer values and the spectroscopic factors for these states were obtained through DWBA analysis of the data. (6 figures, 5 tables) (auth)

8628 SURVEY OF THE QUASIELASTIC (p,n) REACTION INDUCED BY POLARIZED PROTONS. Moss, J. M.; Brassard, C.; Vyse, R.; Gosset, J. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev., C.; 6: No. 5, 1698-1704(Nov 1972).

The differential analyzing power, A(θ), was measured in the quasielastic (p,n) reaction on ^{11}B, ^{27}Al, ^{60}Ni, ^{116}Sn, and ^{120}Sn. The energy of the incident polarized proton beam was 24.5 MeV, except in the case of ^{27}Al where it was 20.3 MeV. The A(θ)'s were oscillatory with a large forward-angle maximum of ±(0.25 to 0.35). Distorted-wave Born-approximation calculations using a macroscopic model give reasonable agreement with the data for ^{27}Al and ^{60}Ni. For the Sn isotopes, good agreement is found when an isospin-dependent spin–orbit term is added to the form factor. The sign of this term agrees with that given by a simple model, but its magnitude is poorly determined due to optical-model ambiguities. (9 figures, 1 table) (auth)

8629 ^{107}Ag(d,p)^{108}Ag AND ^{109}Ag(d,p)^{110}Ag REACTIONS. Brient, C. E.; Riley, P. J.; Seitz, H.; Sen, S. (Univ. of Texas, Austin). Phys. Rev., C.; 6: No. 5, 1837-47(Nov 1972).

The level structures of ^{108}Ag and ^{110}Ag were investigated via the (d,p) stripping reaction on isotopically enriched targets of ^{107}Ag

and ^{109}Ag at an incident deuteron energy of 10.0 MeV. The overall experimental resolution was approximately 20 keV. Proton groups leading to 57 states in ^{108}Ag with excitation energies up to 2.78 MeV and 37 states in ^{110}Ag with excitation energies up to 1.66 MeV were identified. Orbital-angular-momentum-transfer values and spectroscopic factors were extracted for 19 states in ^{108}Ag and for 23 states in ^{110}Ag by using the zero-range distorted-wave Born approximation including an approximation for the nonlocality of the optical potential and a finite-range correction. In ^{108}Ag, six l = 0, nine l = 2, one l = 4, one admixture of l = 0 and l = 2, and two admixtures of l = 2 and l = 4 are assigned. In ^{110}Ag, six l = 0, sixteen l = 2, and one admixture of l = 2 and l = 0 are assigned. It is possible that a small fraction of l = 2 transitions in ^{110}Ag are masked with l = 4 transitions. On this assumption, the effective numbers of neutrons outside the closed $g_{9/2}$ orbital in ^{108}Ag and ^{110}Ag are consistent with the expected values. The summed strengths of the single-particle orbitals are consistent with those of neighboring isotones. (6 figures, 7 tables) (auth)

8630 ELECTRON-CAPTURE DECAY OF ^{105m}Ag. Krien, K.; Spejewski, E. H.; Naumann, R. A.; Huebel, H. (Princeton Univ., N. J.). Phys. Rev., C.; 6: No. 5, 1847-54(Nov 1972).

The electron-capture branch decay of the 7.23-min $7/2^+$ isomer at 25.5 keV in ^{105}Ag was investigated by means of Ge(Li) and NaI(Tl) spectroscopy, by using sources which were both chemically and isotopically processed. It was found that (0.34 ± 0.07)% of the isomeric states decay by the electron-capture process to at least nine levels in ^{105}Pd. The strongest transitions are to levels at 0 keV [(27 ± 16)%, log ft = 6.1], 306.25 keV [(10 ± 1.5)%, 6.3], 319.18 keV [(48 ± 10)%, 5.6], 929.41 keV [(5.3 ± 3.0)%, 5.7], and 1098.39 keV [(2.0 ± 0.8)%, 5.6]. An interpretation of the properties of states in ^{105}Pd in terms of the Nilsson model including Coriolis interactions is attempted. (3 figures, 4 tables) (auth)

8631 (t,p) AND (p,t) REACTIONS ON EVEN Ce ISOTOPES. Mulligan, T. J. (Florida State Univ., Tallahassee); Flynn, E. R.; Hansen, Ole; Casten, R. F.; Sheline, R. K. Phys. Rev., C.; 6: No. 5, 1802-14(Nov 1972).

The (t,p) reaction on ^{138,140}Ce at 15 MeV incident energy and the (p,t) process on ^{142}Ce at 21.5 MeV were studied. Differential cross sections were measured between 12 and 66° in 6° intervals; and L = 0 and 2 assignments, made. Less extensive data on ^{136,142}Ce(t,p) and ^{140}Ce(p,t) were also acquired, and a ^{140}Ce(t,t) angular distribution was obtained at 15 MeV. The strongest L = 0 and L = 2 transitions are discussed in relation to the pairing–vibrational model; in particular, the 3226-keV state in ^{140}Ce was found to contain about 70% of the (1,1) two-phonon strength, and several candidates for pairing-quadrupole–vibrational states are noted. Anharmonic effects on the energies of pairing-phonon states are considered, and a discussion of the observed 3^- strengths is included. (10 figures, 7 tables) (auth)

8632 ELASTIC AND INELASTIC SCATTERING OF α PARTICLES FROM ^{138}Ba. Barker, J. H.; Hiebert, J. C. (Texas A and M Univ., College Station). Phys. Rev., C.; 6: No. 5, 1795-1801(Nov 1972).

Differential cross sections for elastic scattering and inelastic scattering to the low-lying states in ^{138}Ba were measured using 50-MeV α particles. The angular distributions were analyzed in the distorted-wave Born approximation by employing collective-model form factors. Spin and parity assignments of 2^+, 4^+, and 3^- were verified for states at 1.436, 1.898, and 2.880 MeV. Assignments of 2^+ and 4^+ were made for states at 2.19 and 2.27 MeV. Tentative assignments of 2^+ and 4^+ were made for members of unresolved multiplets at 3.34 and 3.50 MeV. Values of $\beta_l R'$ were obtained for all observed levels. Reasonable agreement for excitation energies and J^π assignments was obtained between the present results and previous experimental measurements and with recent theoretical calculations. A comparison of available isoscalar and electromagnetic transition rates in the mass region 115 < A < 150 indicated that, for the lowest 2^+ states, the ratio of the neutron-to-proton contributions to the isoscalar matrix elements is in the ratio N/Z as predicted by the collective vibrational model, except for the N = 82 region. A similar result was previously observed at the N = 28 shell closure. (7 figures, 2 tables) (auth)

8633 STUDY OF THE (d,p) REACTION ON ^{92}Zr AND ^{94}Zr. Fann, H.; Strohbusch, U. (Argonne National Lab., IL). Phys. Rev., C; 6: No. 6, 2299-2303(Dec 1972).

Angular distributions from the (d,p) reaction on ^{92}Zr and ^{94}Zr were measured at 12 MeV with the Argonne split-pole spectrograph. Spectroscopic factors and l values of ^{93}Zr and ^{95}Zr levels up to 2.5-MeV excitation energy were extracted from comparison of the data with distorted-wave Born-approximation calculations. Some unreported levels, in particular, $g_{9/2}$ states previously deduced from results of the (^{3}He,d) reaction to the corresponding analog states, were identified. (4 figures, 4 tables) (auth)

8634 MULTIPLE EXCITATION OF THE SECOND 0^+ STATE IN ^{90}Zr. Love, W. G. (Univ. of Georgia, Athens). Phys. Lett.; 42B: No. 1, 13-16(13 Nov 1972).

Multiple excitation is found to be important for the inelastic excitation of the second 0^+ state in ^{90}Zr when shell-model wave functions supplemented by core polarization effects of the quadrupole type are used. Inelastic proton, deuteron, triton, and α-particle scattering data are considered. (auth)

8635 INVESTIGATION OF A SHORT-LIVED ISOMERIC STATE IN ^{115}Te. Vajda, S.; Iordachescu, A.; Ivanov, E. A.; Pascovici, G. (Inst. of Atomic Physics, Bucharest). Phys. Lett.; 42B: No. 1, 54-6(13 Nov 1972).

An $11/2^-$ isomeric state was identified in ^{115}Te by pulsed-beam time differential γ-ray measurements following the ^{112}Sn(α,n) reaction. The results obtained in this experiment are $T_{1/2}$ = 7.5 ± 0.2 μs, E_γ = 279.0 ± 0.5 keV, α_k = 0.14 ± 0.03, g = −0.186 ± 0.007. (auth)

8636 ^{116}In LEVEL SCHEME AND p–n CONFIGURATIONS. Rabenstein, D. (Univ., Munich); Harrach, D.; Vonach, H.; Dussel, G. G.; Perazzo, R. P. I. Nucl. Phys.; A197: No. 1, 129-62 (1972).

The low-energy and high-energy γ-ray spectra associated with the reaction ^{115}In(n,γ)^{116}In have been measured with Ge(Li) detectors and a Ge(Li)–NaI(Tl) pair spectrometer. A γ–γ coincidence study has been performed using a Ge(Li)–Ge(Li) coincidence system. Combining these measurements with the results of (d,p) and other (n,γ) studies, a level scheme for ^{116}In up to 1.4 MeV is proposed. In particular, seven states of the $(\pi(g_{9/2})^{-1}, \nu h_{11/2})$ multiplet (3^- to 9^-) are unambiguously identified and the anomalous high isomeric cross-section ratio of the second isomeric state is explained. The binding energy B_n of the last neutron in ^{116}In has been determined to be 6784 ± 1.2 keV. From the energy splitting of the fairly pure high-spin states of the $(\pi(g_{9/2})^{-1}, \nu h_{11/2})$ multiplet, the coupling constant of the quadrupole part of the residual proton–neutron interaction κ_2 is calculated in a spherical basis. The κ_2 obtained is about 5 times larger than the one normally used in calculations of quadrupole oscillations in double even nuclei. This discrepancy is discussed, and an explanation in terms of an isovector component of the quadrupole interaction is proposed. (auth)

8637 REORIENTATION EFFECT IN ^{110}Cd AND ^{114}Cd. Berant, Z. (Weizmann Inst. of Science, Rehovot, Israel); Eisenstein, R. A.; Horowitz, Y.; (and others). Nucl. Phys.; A196: No. 2, 312-36(1972).

New detailed measurements of the reorientation effect in the first 2^+ state of ^{110}Cd and ^{114}Cd were carried out using back-scattered ^{4}He and ^{16}O ions. They yield Q_{2+} = −0.28 ± 0.09 e·b with B(E2; 0 → 2) = 0.513 ± 0.005 $e^2 \cdot b^2$, or Q_{2+} = −0.03 ± 0.09 e·b with B(E2; 0 → 2) = 0.512 ± 0.005 $e^2 \cdot b^2$ for ^{114}Cd depending on the sign of the interference term. The results for ^{110}Cd are Q_{2+} = −(0.42 or 0.21) ± 0.10 e·b with B(E2; 0 → 2) = 0.432 ± 0.006 $e^2 \cdot b^2$. The deduced Q_{2+} for ^{114}Cd is approximately half of the rotational-model value. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 8514, 8560, 8579, 8653, 8713, and 8714.

8638 (COO-1672-36) RADIOCHEMICAL INVESTIGATIONS OF NUCLEAR PROPERTIES. Progress Report for the Period October 1971–September 1972. Daly, P. J. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Sep 1972. Contract AT(11-1)-1672. 9p. Dep. NTIS.

Nuclear structure studies in the A = 180 to 200 region conducted using neutron transfer spectroscopy, decay spectroscopy, and in-beam γ-ray spectroscopy are briefly reported. A list of publications resulting from the studies is included. (J.W.R.)

8639 (LYCEN-7234) STUDY OF $1/2^+$, $3/2^+$, AND $5/2^+$ LEVELS IN ^{165}Er. Marguier, G.; Chery, R. (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1972. 12p. (In French). Dep. NTIS (U. S. Sales Only).

A new scheme for the positive-parity levels of ^{165}Er excited during the disintegration of ^{165}Tm is proposed. The $1/2$, $3/2$ and $5/2$ spin levels are interpreted in terms of the classic deformed nuclei models with Coriolis and ΔN = 2 coupling between the Nilsson orbitals. (France)

8640 DECAY OF ^{161}Er TO ^{161}Ho. Kaun, K. H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.); Funke, L.; Kemnitz, P.; (and others). Nucl. Phys.; A194: No. 1, 177-92(1972).

The level scheme of the deformed odd-proton nucleus ^{161}Ho was

investigated in the electron-capture decay of ^{161}Er using germanium detectors, a magnetic β-spectrograph and two $\pi\sqrt{2}$ double-focussing β-spectrometers. In addition to the measurements of singles γ-ray and conversion-electron spectra extensive γ-γ coincidence measurements were performed. A decay scheme is proposed involving 37 excited states in ^{161}Ho. In the low-energy region the first members of the rotational bands $^{7}/_{2}^{-}$[523], $^{1}/_{2}^{+}$[411], $^{7}/_{2}^{+}$[404], $^{3}/_{2}^{+}$[411], $^{1}/_{2}^{-}$[541], $^{5}/_{2}^{+}$[413], and $^{5}/_{2}^{-}$[532] were identified. Furthermore, the first two members of the γ-vibrational band $K_0=2$ built on the ground state and an additional band with the probable quantum characteristic $K^{\pi} = {}^{5}/_{2}^{+}$ (band head at 446.9 keV) have been found. Possible interpretations of the high-lying levels are discussed on the basis of current models. (auth)

8641 HALF-LIFE OF LONG-LIVED ^{176}Lu. Komura, K.; Sakamoto, K.; Tanaka, S. (Tokyo Univ.). Nucl. Phys.; A198: No. 1, 73-80(1972).

The half-life of naturally occurring ^{176}Lu has been redetermined to be $(3.79 \pm 0.03) \times 10^{10}$ y from γ-ray measurements, using a Ge(Li) and a NaI(Tl) detector. Two independent lutetium sources were used: the oxide of isotopically enriched ^{176}Lu and the oxide of natural abundance. (auth)

8642 GROUND STATE ROTATIONAL BANDS IN ^{158}Dy, ^{160}Dy, AND ^{162}Dy. Ewan, G. T.; Andersson, G. I. (Chalk River Nuclear Labs., Ont.). Proc. Roy. Soc. Edinburgh, Sect. A; 70: 155-63(1972).

Levels in the ground state bands of ^{158}Dy, ^{160}Dy, and ^{162}Dy have been populated by (α,2n) reactions on metallic targets of separated ^{156}Gd, ^{158}Gd, and ^{160}Gd isotopes. Two Ge(Li) detectors were used to study singles gamma-ray spectra, gamma-ray angular distributions, gamma–gamma coincidence spectra and relative yields of gamma-rays for bombarding energies from 20 to 27 MeV. Transitions from all levels in the ground state bands up to the 12+ member were identified and the following level energies in keV established: ^{158}Dy: 0(0+), 99.0 (2+), 317.4 (4+), 637.9 (6+), 1044.1 (8+), 1520.1 (10+), and 2049.4 (12+); ^{160}Dy: 0 (0+), 86.7 (2+), 283.7 (4+), 581.4 (6+), 967.4 (8+), 1429.0 (10+), 1951.7 (12+); ^{162}Dy: 0 (0+), 80.7 (2+), 265.7 (4+), 548.5 (6+), 921.1 (8+), 1374.8 (10+), and 1901.0 (12+). There is weak evidence for the 14+ levels in ^{158}Dy and ^{160}Dy. The level energies are compared with calculated values using the variable moment of inertia model. (auth)

8643 ROTATIONAL STATES IN ^{171}Hf. Rezanka, I. (Yale Univ., New Haven); Rasmussen, J. O.; Bernthal, F. M.; (and others). Nucl. Phys.; A197: No. 2, 430-48(1972).

Alpha-particle irradiation of an enriched ytterbium target and ^{10,11}B irradiation of a holmium target were used to populate excited states in ^{171}Hf. Rotational bands built on the $^{7}/_{2}^{+}$[633], $^{5}/_{2}^{-}$[512], and $^{1}/_{2}^{-}$[521] Nilsson states were followed up to levels with spins $^{29}/_{2}$, $^{25}/_{2}$, and $^{29}/_{2}$, respectively. The observed energy levels and transition probabilities are compared with the predictions of the rotational model and with the results of a Coriolis coupling calculation. (auth)

8644 ENERGY LEVELS OF ^{177}Ta. Ader, B. L.; Perrin, N. N. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A197: No. 2, 593-619(1972). (In French).

The energy levels of the odd-proton nucleus ^{177}Ta have been studied from the electron-capture decay of 2.2 h ^{177}W by means of magnetic spectrometers (axial, high-resolution permanent field, with and without pre-acceleration, iron-free double focussing), Si(Li), Ge(Li), and NaI(Tl) detectors and a proportional counter. Multidimensional coincidences (γ-γ and e-γ) involving time measurement have been performed with various combinations of these detectors. A level scheme is presented where the following intrinsic Nilsson states are identified in ^{177}Ta: $^{7}/_{2}^{+}$[404], ground; $^{9}/_{2}^{-}$[514] at 73.15 keV; $^{3}/_{2}^{+}$[411] at 865.0 keV; and the first rotational levels built on the $^{5}/_{2}^{+}$[402] state at 70.45 keV; the $^{1}/_{2}^{-}$[541] state at 186.2 keV; the $^{1}/_{2}^{+}$[411] state at 487.6 keV. The transition probabilities of these levels and log ft values of the ^{177}W decay are deduced. (auth)

8645 E1 TRANSITION PROBABILITIES BETWEEN THE NILSSON STATES $^{1}/_{2}^{+}$[411] AND $^{1}/_{2}^{-}$[541]. Loebner, K. E. G.; Bennett, M. J.; Bunker, M. E. (Los Alamos Scientific Lab., NM). Nucl. Phys.; A197: No. 2, 553-67(1972).

The half-lives of the $^{1}/_{2}$, $^{1}/_{2}^{+}$[411] level at 208.1 keV in ^{171}Lu and of the $^{1}/_{2}$, $^{1}/_{2}^{+}$[411] and $^{3}/_{2}$, $^{1}/_{2}^{+}$[411] levels at 425.0 and 434.6 keV in ^{173}Lu have been measured in the decay of ^{171}Hf and ^{173}Hf to be 29.7 ± 1.1 ns, 0.82 ± 0.20 ns and 0.46 ± 0.20 ns, respectively. These half-lives yield the absolute γ-ray transition probabilities of the E1 transition from $^{1}/_{2}$, $^{1}/_{2}^{+}$[411] to $^{1}/_{2}$, $^{1}/_{2}^{-}$[541] in ^{171}Lu and of the E1 transitions from $^{1}/_{2}$, $^{1}/_{2}^{+}$[411] to the spin $^{1}/_{2}$ and $^{3}/_{2}$ members of the $^{1}/_{2}^{-}$[541] band and from $^{3}/_{2}$, $^{1}/_{2}^{+}$[411] to the spin $^{3}/_{2}$ and $^{5}/_{2}$ members of the $^{1}/_{2}^{-}$[541] band in ^{173}Lu. These absolute transition probabilities are found to be in good agreement with the Nilsson estimate, taking into account pairing correlations and Coriolis coupling. (auth)

8646 RELATIVE TRANSITION PROBABILITIES FROM THE γ-VIBRATIONAL BAND OF ^{186}Os. Fogelberg, B. (Uppsala Univ.). Nucl. Phys.; A197: No. 2, 497-514(1972).

Energies and relative intensities of γ-rays from the decays of ^{186}Ir and ^{186}Re have been measured with a high-resolution Ge(Li) detector with a well-known detection efficiency. This paper deals only with data of relevance for the γ-vibrational band in ^{186}Os of which the 2^+ to 6^+ levels are strongly populated in the decay of ^{186}Ir. A partial level scheme for the γ-band, slightly modified from previous ones, is presented. The deduced level energies and the measured γ-ray intensities are discussed with reference to nuclear models. It was found that the relative B(E2) values forming the γ-band levels cannot be explained by the Alaga rule corrected by a single value of the band-mixing parameter z_2. (auth)

8647 NUCLEAR ORIENTATION AND PARITY-MIXING STUDIES OF THE DECAYS OF ^{171}Er AND ^{169,175}Yb. Krane, K. S.; Olsen, C. E.; Steyert, W. A. (Los Alamos Scientific Lab., NM). Nucl. Phys.; A197: No. 2, 352-68(1972).

Angular distributions of γ-radiations emitted by ^{171}Er and ^{169,175}Yb have been studied from radioactive samples polarized at low temperatures. The magnetic hyperfine field of Er in $ZrFe_2$ was deduced to be 8.3 ± 1.0 MG, based on the anisotropies of the ^{171}Tm γ-rays. The magnitudes of the ^{169}Yb and ^{175}Yb magnetic moments were deduced to be 0.63 ± 0.09 μ_N and 0.40 ± 0.05 μ_N, respectively, based on γ-ray anisotropies following the decay of samples polarized in Au. Gamma rays from ^{177}Lu were observed to be emitted isotropically, indicating the lack of Lu polarization in Au. The E2/M1 and M2/E1 multipole mixing ratios were deduced for most of the mixed γ-transitions in ^{169,171}Tm and ^{175}Lu. Investigations of the forward-backward asymmetry of the angular distributions of a number of strongly hindered γ-transitions in ^{169,171}Tm and ^{175}Lu revealed no effect attributable to parity mixing in the nuclear states. (auth)

8648 DECAYS OF 5.5 MIN ^{168g}Lu AND 6.7 MIN ^{168m}Lu. Charvet, A.; Chery, R.; Do Huu Phuoc; (and others) (Univ. Claude Bernard, Lyon). Nucl. Phys.; A197: No. 2, 490-6(1972).

In order to clear up important discrepancies among previous investigations, the decay of ^{168}Lu, produced through the ^{169}Tm(α, 5n) reaction, has been re-investigated. Instead of the well-known 7 min activity, evidence has been obtained for two distinct decays with half-lives of 5.5 min and 6.7 min. The corresponding Q-values have been determined to be respectively 4470 ± 80 keV and 4690 ± 100 keV. The decay schemes are given for each isomeric state. The assignments 6^-(p404↓ + n523↓) and 3^+(p541↓ + n523↓) are proposed for ^{168g}Lu (5.5 min) and ^{168m}Lu (6.7 min), respectively. The structure of the levels are discussed in the framework of current nuclear models. (auth)

8649 HALF-LIVES OF ^{171}Ta AND ^{172}Ta. Chang, S. K. (Univ. of Chicago); Cheney, M. C. Phys. Rev., C.; 6: No. 5, 1898-9(Nov 1972).

The half-lives of ^{171}Ta and ^{172}Ta were determined. The nuclides were produced by the spallation reaction ^{181}Ta(p,pxn) at a proton bombarding energy of 450 MeV. The half-life of ^{171}Ta was found to be 23.3 ± 0.3 min, in good agreement with the literature value. A previously unreported γ ray at 1087 keV is probably assignable to ^{171}Ta decay. The half-life of ^{172}Ta was found to be 36.7 ± 0.4 min. (2 figures). (auth)

8650 EVIDENCE FOR THE α DECAY OF THE NEW ISOTOPE ^{169}Os. Toth, K. S. (Oak Ridge National Lab., TN); Hahn, R. L.; Bingham, C. R.; Ijaz, M. A.; Walker, R. F. Jr. Phys. Rev., C; 6: No. 6, 2297-9(Dec 1972).

In a series of ^{20}Ne bombardments of ^{156}Dy a new α emitter was identified with a half-life of 3.0 ± 0.5 s and an α-decay energy of 5.56 ± 0.02 MeV. On the basis of α-decay systematics and the variation of its yield with bombarding energy, the most likely nuclidic assignment for this α group is ^{169}Os. (1 figure, 1 table). (auth)

8651 ELECTRIC HEXADECAPOLE TRANSITION MOMENTS IN ^{152,154}Sm. Saylor, T. K.; Saladin, J. X.; Lee, I. Y.; Erb, K. A. (Univ. of Pittsburgh). Phys. Lett.; 42B: No. 1, 51-3(13 Nov 1972).

The E4 reduced matrix elements between the ground state and the 4^+ rotational state in ^{152}Sm and ^{154}Sm were determined by Coulomb excitation measurements. The results are $\langle 0^+||M(E4)||4^+\rangle$ = 0.35 ± 0.07 eb^2 for ^{152}Sm and 0.43 ± 0.08 eb^2 for ^{154}Sm. The B(E2; $0^+ \rightarrow 2^+$) values measured are 3.39 ± 0.03 e^{2}b^2 for ^{152}Sm and 4.30 ± 0.03 e^{2}b^2 for ^{154}Sm. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 8295, 8513, 8514, 8524, 8530, 8536, 8539, 8546, 8579, 8596, 8626, 8638, and 8714–8716.

8652 MULTIPOLE MIXING RATIOS OF γ-TRANSITIONS IN ^{208}Pb. I. Jagam, P.; Murty, D. S. (Saint Mary's Univ., Halifax, Nova Scotia). Nucl. Phys.; A197: No. 2, 540-52(1972).

A calibrated Ge(Li)-NaI(Tl) correlation spectrometer has been used to measure the directional correlations of 277, 511, 583 and 860 keV transitions in coincidence with the 2614 keV transition in ^{208}Pb with solid and liquid sources of ^{228}Th. From the measured 1−2 and 1−3 correlation coefficients the multipole character and mixing ratios δ have been deduced. These values are used to calculate the multipole moment ratios $\Delta = \{[I_{n+1}||M(E2)||I_n]/[I_{n+1}||M(M1)||I_n]\}$ of Bohr and Mottelson for the above transitions; in natural units they are: Δ(277) = 51.1 ± 4.3, Δ(511) = −4.4 ± 2.3 and Δ(860) = 0.05 ± 0.04. (auth)

8653 MEASUREMENTS OF NUCLEAR RADII BY HEAVY-ION SCATTERING. Friedman, A. M. (Argonne National Lab., IL); Siemssen, R. H.; Cuninghame, J. G. Phys. Rev., C; 6: No. 6, 2219-23(Dec 1972).

The elastic scattering of ^{12}C and ^{16}O by ^{208}Pb, ^{206}Pb, ^{209}Bi, ^{144}Nd, ^{146}Nd, ^{148}Nd, ^{152}Sm, and ^{154}Sm was studied in order to determine the strong-absorption radii and to see if these may be influenced by Coulomb distortion effects. It was found that these Coulomb effects were small and all radii could be described by a radius parameter, R_0, between 1.30 and 1.44 fm. (2 figures, 3 tables) (auth)

8654 GAMMA–GAMMA–GAMMA ANGULAR-CORRELATION METHOD FOR THE STUDY OF 308 → 296 → 316-keV CASCADE IN ^{192}Pt. Singh, B. P.; Dahiya, H. S. (Roorke Univ., India). Phys. Rev., C.; 6: No. 5, 1789-94(Nov 1972).

A γ−γ−γ angular-correlation method is suggested for the case where all three γ rays are of approximately the same energy. This method was employed for the study of the 308 → 296 → 316-keV cascade in ^{192}Pt from the decay of ^{192}Ir. The E_2/M_1 mixing ratio of the 308-keV γ rays thus obtained was $(-)4.4^{+\infty}_{-0.7}$. (5 figures, 2 tables) (auth)

8655 DISTORTED-WAVE THEORY OF DEUTERON BREAK-UP. Rybicki, Frank (Univ. of Pittsburgh); Austern, N. Phys. Rev., C.; 6: No. 5, 1525-35(Nov 1972).

Deuteron-breakup coincidence cross sections are calculated in the prior-interaction formulation of distorted-wave Born approximation (DWBA); both nuclear and Coulomb interactions are included. The results disagree with experiment. This disagreement is attributed to incorrect treatment of Coulomb distortion in the prior form of the outgoing wave function. Nuclear contributions to breakup are found to be as important as Coulomb contributions. Numerical procedures are developed that can also be used to include Coulomb excitation in DWBA calculations of inelastic scattering. (6 figures, 4 tables) (auth)

8656 EXCITED STATES IN ^{206}Pb FROM THE DECAY OF ^{206}Bi. Manthuruthil, J. C. (Aerospace Research Labs., Wright-Patterson AFB, Ohio); Camp, D. C.; Ramayya, A. V.; (and others). Phys. Rev., C.; 6: No. 5, 1870-89(Nov 1972).

Chemically separated and isotopically separated sources of 6.2-day ^{206}Bi produced by the (p,xn) reactions on lead were used to study the excited states of ^{206}Pb. γ-ray data were taken with a Compton-suppression spectrometer and with a Ge(Li)−Ge(Li) two-parameter analyzer system. From these, 66 γ rays were identified in the decay of ^{206}Bi; and 61 of these transitions were placed from coincidence results, energy sums and differences, and intensity considerations into a decay scheme with 19 excited states. New levels at 2826.4, 2939.6, 3225.5, and 3244.1 keV were deduced. Spins and parities for all but one excited state were deduced from published internal-conversion electron intensities, relative γ-ray intensities, log-ft values, and existing angular distribution measurements from particle reactions. The branching ratios, transition multipolarities, and lifetimes for many of the ^{206}Pb levels were calculated by using the wave functions that result from shell-model calculations with phenomenological as well as realistic interactions, and calculations using the two-nucleon random phase approximation. (5 figures, 6 tables) (auth)

8657 WIDTHS OF ANALOG STATES IN Bi AND Po FROM (p,n) SPECTRA. Crawley, G. M.; Miller, P. S.; Galonsky, A.; Amos, T.; Doering, R. (Michigan State Univ., East Lansing). Phys. Rev., C.; 6: No. 5, 1890-3(Nov 1972).

Isobaric analog states were observed in the neutron spectra of (p,n) reactions on targets of ^{206}Pb, ^{207}Pb, ^{208}Pb, and ^{209}Bi. After removal of instrumental resolution effects, the natural widths are, respectively, 196 ± 26, 203 ± 32, 202 ± 34, and 151 ± 34 keV. Except in the ^{206}Pb case, these widths are substantially smaller than those observed in $\bar{p}$ spectra from (p,n$\bar{p}$) experiments on the same target nuclei but are in agreement with (p,p′) resonance results in the two cases that have been measured. (2 figures, 2 tables) (auth)

8658 EFFECT OF A VOLUME FORM OF THE PARTICLE–VIBRATION COUPLING IN FAST NUCLEON RADIATIVE CAPTURE. Longo, G.; Saporetti, F. (Comitato Nazional Energia Nucleaire, Bologna). Phys. Lett.; 42B: No. 1, 17-20(13 Nov 1972).

The semidirect nucleon radiative capture cross section is calculated using a volume radial form factor for the particle–vibration coupling instead of the previous surface form factor. A significant improvement in the agreement between theory and experiment is thus obtained. (auth)

8659 DEUTERON BREAK-UP ON HEAVY NUCLEI AROUND THE COULOMB BARRIER. Baur, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Trautmann, D. Phys. Lett.; 42B: No. 1, 31-4(13 Nov 1972).

A method to calculate the break-up of the deuteron in the field of a heavy nucleus which takes both nuclear and Coulomb interactions into account is discussed. The results are in very good agreement with experiment. (auth)

8660 MAGNETIC HYPERFINE INTERACTION OF THE 2^+ ROTATIONAL STATES IN MUONIC ^{190,192}Os. Link, R.; Schellenberg, L.; Backe, H.; (and others) (CERN, Geneva). Phys. Lett.; 42B: No. 1, 57-9(13 Nov 1972).

In muonic ^{190,192}Os the magnetic hf splitting of the $2^+ \rightarrow 0^+$ nuclear transition was measured. The hf splittings $\Delta E(^{190}Os) = 665 \pm 80$ eV and $\Delta E(^{192}Os) = 800 \pm 80$ eV of the 2^+ state are reduced to 59% compared to a point-like magnetic moment, in agreement with the assumption of a magnetization density distribution proportional to $R^2\rho_{charge}(R)$ as calculated from a rigid rotator. The influence of these results on the analysis of muonic isomer shifts is pointed out. (auth)

8661 TWO-QUASIPARTICLE ISOMERIC STATES IN DOUBLY ODD Bi NUCLEI. Hagemann, U.; Kaun, K. H.; Neubert, W.; Schulze, W.; Stary, F. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A197: No. 1, 111-20(1972).

In the reactions ^{191}Ir(^{12}C,5n)^{198}Bi and ^{193}Ir(^{12}C,5n)^{200}Bi isomeric states were observed with half-lives $T_{½} = 7.7 \pm 0.5$ s and $T_{½} = 0.40 \pm 0.05$ s, respectively, which are ascribed to the 10^- states with a configuration $\pi(h_{9/2})^1\nu(i_{13/2})^{-1}$. In ^{200}Bi a second isomeric level with half-life $T_{½} = 46 \pm 4$ ns was found. (auth)

8662 PHOTON-INDUCED NUCLEAR REACTIONS ABOVE 1 GeV. III. FISSION IN GOLD AND LEAD. Kroon, I.; Forkman, B. (Lund Inst. of Tech., Sweden). Nucl. Phys.; A197: No. 1, 81-7 (1972).

The photofission cross section per equivalent quantum and the forward-to-backward ratios of gold and lead have been measured in the bremsstrahlung energy range 1.0 to 7.4 GeV using glass detectors. The experimental data are analyzed using data from an earlier lower-energy experiment done at Lund with the same experimental technique. It is verified that the fission cross sections for the two target elements are almost constant above 1 GeV. From the moderate dependence of the forward-to-backward ratio on photon energy it is concluded that the excitation energy of the fissioning nucleus and the momentum transferred to it are rather independent of photon energy. The forward momentum deposited at the instant of fission is shown to increase only slowly, decreasing from 40% to 10% of the compound-nucleus value in the energy interval studied. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 8514, 8539, 8579, and 8721.

8663 (JINR-E6-6597) TWO-QUASIPARTICLE ISOMERIC STATES IN DOUBLY-ODD Bi NUCLEI. Hagemann, U.; Kaun, K.-H.; Neubert, W.; Schulze, W.; Stary, F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 21p. Dep. NTIS (U. S. Sales Only).

In the reactions ^{191}Ir(^{12}C,5n)^{198}Bi and ^{193}Ir(^{12}C,5n)^{200}Bi isomeric states were observed with half-lives $T_{½} = 7.7 \pm 0.5$s and $T_{½} = 0.40 \pm 0.05$s, respectively, which are ascribed to the 10^- states with configuration $\pi(h_{9/2})^1\ \nu(i_{13/2})^{-1}$. In ^{200}Bi a second isomeric level with half-life $T_{½} = 46 \pm 4$ns was found. (auth)

8664 ENERGY DEPENDENCE OF THE FISSIONABILITY OF NEPTUNIUM ISOTOPES AND THE LEVEL DENSITY OF HIGHLY DEFORMED NUCLEI. Bishop, C. J.; Halpern, I.; Shaw, R. W. Jr.; Vandenbosch, R. (Univ. of Washington, Seattle). Nucl. Phys.; A198: No. 1, 161-87(1972).

The relative probability, Γ_n/Γ_f, of neutron evaporation and fission was determined for neptunium isotopes produced in bombardments of ^{238}U with protons of energy up to 22 MeV. The measurement involved the comparison of the numbers of neutrons emitted at 0° to fission fragments with those emitted at 90°. The observa-

tions are incompatible with the statistical theory expressions for Γ_n/Γ_f using the Fermi-gas expression for nuclear level densities with deformation-independent values for the level density parameter, a. They can be brought into accord with the theory if the value of a at the saddle point distortion is 10 to 15% larger than that near the normal ground state. A difference of about this magnitude is suggested by microscopic calculations of the relevant level densities when they are allowed to include single-particle and pairing effects. (auth)

8665 INDEPENDENT YIELDS OF ^{133,135}Xe IN THE FISSION OF ^{235}U, ^{238}U, AND ^{239}Pu BY 14 MeV NEUTRONS. Alexander, Peter (Teledyne Isotopes, Westwood, NJ). Nucl. Phys.; A198: No. 1, 228-36(1972).

The direct fission populations of states in ^{133,135}Xe have been measured for fission induced by 14-MeV neutrons. Targets consisting of metal foils of ^{235}U, ^{238}U, and ^{239}Pu were separately encapsulated and irradiated for periods of 1 to 8 min in a flux of 1.5×10^{11} n/cm$^2 \cdot$ s. The xenon isotopes of interest were extracted from the bulk fission products within 3 to 12 min after irradiation. The xenon γ-rays were then examined with a Ge(Li) detector and the populations of the ^{133,135}Xe isomer and ground states were deduced. Computer analysis techniques were employed to extract the independent fission yield values from this data. (auth)

8666 M1 TRANSITIONS IN ^{208}Bi. Olin, A.; Haeusser, O.; Ward, D.; Disdier, D. L. (Chalk River Nuclear Labs., Ont.). Nucl. Phys.; A197: No. 2, 583-92(1972).

Electromagnetic matrix elements of some low-lying states in ^{208}Bi have been determined. Lifetimes of the following levels have been measured using the reaction ^{207}Pb(^{7}Li,α2nγ)^{208}Bi and the Doppler-shift attenuation method: 1.095 MeV ($\tau = 0.19^{+0.07}_{-0.05}$ ps), 0.886 MeV ($\tau = 0.26^{+0.12}_{-0.08}$ ps), 1.069 MeV ($\tau = 0.64^{+0.31}_{-0.16}$ ps), 1.033 MeV ($\tau = 1.04^{+0.38}_{-0.24}$ ps), 0.936 MeV ($\tau > 2.5$ ps) and 1.539 MeV ($\tau > 1.7$ ps). The lifetimes of these levels are very sensitive to configuration mixing through the residual nucleon-nucleon interaction. The results are compared to predictions from nuclear structure calculations by Kuo. (auth)

8667 ELASTIC SCATTERING OF ^{84}Kr IONS ON ^{238}U AND THE DISTANCE OF APPROACH FOR THE REACTION THRESHOLD. Lefort, M.; Ngo, C.; Peter, J.; Tamain, B. (Institut Physique Nucleaire, Orsay, France). Nucl. Phys.; A197: No. 2, 485-9(1972). (In French).

The elastic scattering cross section of Kr ions on a uranium target has been measured at backward angles. By varying the bombarding energy, it has been shown that the elastic scattering cross section diminishes sharply around 450 MeV, i.e. 333 ± 7 MeV in the cm. The significance of this value is discussed in terms of distance of approach for nuclear interactions between heavy nuclei. (auth)

8668 REINVESTIGATION OF THE LEVELS IN ^{238}Pu FROM THE DECAY OF ^{238}Np. Winter, W. J. B.; Wapstra, A. H.; Goudsmit, P. F. A.; Konijn, J. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys.; A197: No. 2, 417-22(1972).

With an anti-Compton spectrometer, some new weak lines are observed in the β-decay of ^{238}Np. The existence of the 968.9 keV 2^- level in ^{238}Pu suggested earlier on the basis of delayed coincidence results is confirmed. Feeding is observed of the 983.0 keV 2^+ state of the β-vibrational band. The results, and especially branching ratios of transitions in ^{238}Pu, are compared with those obtained in the decay of ^{238}Am. (auth)

8669 NEUTRON RESONANCE SPECTROSCOPY. X. ^{232}Th AND ^{238}U. Rahn, F.; Camarda, H. S.; Hacken, G.; (and others) (Columbia Univ., New York). Phys. Rev., C.; 6: No. 5, 1854-69 (Nov 1972).

Neutron time-of-flight spectroscopy measurements were made for a range of sample thicknesses of ^{232}Th and ^{238}U at the Nevis synchrocyclotron. These included transmission measurements using 200- and 40-m paths, self-indication measurements at 40 m, and Moxon–Rae capture measurements at 33 m. Resonance energies and Γ_n values were obtained for n = 302 levels in ^{232}Th to 4.0 keV and 269 levels in ^{238}U to 4.6 keV, with essentially no missed s levels and inclusion of a significant number of p levels. Γ_γ values were obtained for 84 levels in ^{232}Th and 71 in ^{238}U to 2400 eV, with $\langle\Gamma_\gamma\rangle$ = [21.2 ± 0.3 (stat.) ±0.9 (syst.)] MeV (^{232}Th) and [22.9 ± 0.5 (stat.) ±0.9 (syst.)] MeV (^{238}U). In both cases a χ^2 analysis gives ~100 degrees of freedom including the effects of measurement errors. The values for the resonance energies were obtained from the data before the analysis was completed for Γ_n and Γ_γ values. The division of the levels into s and p populations, described in detail elsewhere, was made to achieve a "best" fit to many statistical tests relating to the orthogonal-ensemble theory for single-level populations, with a resulting good fit to numerous tests. For the chosen s-level population, 10^4 S_0 = (0.84 ± 0.08) for ^{232}Th and (1.08 ± 0.10) for ^{238}U. The s-population $\langle D\rangle$ = 16.7 eV (^{232}Th) and 20.8 eV (^{238}U). The fits to the Porter–Thomas theory for Γ_n^0 distributions were generally good for the full 3-keV regions, with a small anomaly for the behavior of ^{232}Th to 500 eV, which has been reported by others. The remaining p levels have Γ_n values which are consistent with p strength function 10^4 $S_1 \sim 0.9$ for ^{232}Th to 400 eV and 10^4 $S_1 \sim 1.4$ for ^{238}U to 1200 eV. Larger S_1 values by other groups are due to their inclusion, as stronger p levels, ones which here are designated s levels. Effective potential scattering radii were found to be (9.1 ± 0.3) fm for ^{232}Th and (9.6 ± 0.3) fm for ^{238}U. (11 figures, 5 tables) (auth)

8670 COMPARISON OF YIELDS FROM FISSION OF ^{233}U, ^{234}U, ^{235}U, ^{236}U, AND ^{238}U WITH 14.8-MeV NEUTRONS. Nethaway, D. R.; Mendoza, B. (Univ. of California, Livermore). Phys. Rev., C.; 6: No. 5, 1827-37(Nov 1972).

Mass-yield distributions from fission of ^{233}U, ^{234}U, ^{235}U, ^{236}U, and ^{238}U by 14.8-MeV neutrons were analyzed to study the details of the fission distribution as a function of target mass number at a fairly low excitation energy. The fission yields of individual products, both cumulative and independent, vary smoothly and as expected with uranium target mass number. The overall distribution of yields becomes significantly narrower as the uranium mass number is increased. The average neutron emission associated with the very-low-yield products is about 3.5, significantly less than the value of about 4.5 for the fission fragments as a whole. This difference may be due to an increase in energy required for reactions leading to the low-yield products. The peak/valley ratio increases by a factor of more than 2 as the mass number is increased from 233 to 238, and decreases linearly with increasing excitation energy, with the even-mass and odd-mass uranium isotopes defining lines that are approximately parallel and separated by 1.4 MeV. This difference can be explained either by an odd–even effect in the neutron-evaporation/fission competition as a function of target mass number, or by an odd–even effect in the ratio of symmetric to asymmetric fission as a function of mass number. One consequence of the rapid change in peak/valley ratio with mass number is that fission of ^{232}U with 14.8-MeV neutrons would be expected to produce a flat-topped mass-yield distribution, with a peak/valley ratio of about unity, while fission of lower-mass uranium isotopes would be expected to be predominantly symmetric. The average value of $\Delta Z_p/\Delta A$ was found to be −0.16 ± 0.02 for the shielded product ^{96}Nb and −0.20 ± 0.01 for ^{136}Cs. This difference may be due to the change in prefission neutron emission with uranium mass number. All of the available data on fractional chain yields for fission of ^{236}U* at E* = 6.4 and 21.3 MeV were used to estimate $\Delta Z_p(A)$ for ΔE^* = 15 MeV. The scatter in the ΔZ_p values is too large to allow a smooth curve to be drawn relating ΔZ_p as a function of mass number. It was found, however, that ΔZ_p values are larger on the average for heavy-fragment products (ΔZ_p = 0.49 ± 0.05) than for light-fragment products (ΔZ_p = 0.26 ± 0.03) over this range of excitation energy. The well-known $Z_p(A)$ function for thermal-neutron fission of ^{235}U, together with the $\Delta Z_p/\Delta A$ and $\Delta Z_p/\Delta E^*$ relationships reported here, can be used to estimate Z_p values and fractional chain yields for fission of the various uranium isotopes by 14.8-MeV neutrons. (9 figures, 6 tables) (auth)

8671 FISSION OF ^{234}U AND ^{236}U WITH 14.8-MeV NEUTRONS. Nethaway, D. R.; Mendoza, B. (Univ. of California, Livermore). Phys. Rev., C.; 6: No. 5, 1821-6(Nov 1972).

Mass-yield distributions from fission of ^{234}U and ^{236}U with 14.8-MeV neutrons were determined. The yields of 24 products covering the mass range 66 to 161 for ^{234}U and for 30 products covering the mass range 66 to 172 for ^{236}U were measured. Total chain yields were estimated by correcting for the effects of nuclear-charge dispersion in fission. The mass-yield curves are similar to those for fission of ^{233}U, ^{235}U, and ^{238}U with 14.8-MeV neutrons. The independent fractional chain yields of the following nuclides were measured: for ^{234}U: ^{96}Nb (1.54 ± 0.10) × 10^{-3}; ^{136}Cs, 0.095 ± 0.006; for ^{236}U: ^{96}Nb, (2.7 ± 0.3) × 10^{-4}; ^{126}Sb, 0.096 ± 0.010; ^{136}Cs, 0.022 ± 0.002. (4 figures, 4 tables) (auth)

8672 PHOTON-INDUCED NUCLEAR REACTIONS ABOVE 1 GeV. IV. MASS DISTRIBUTION IN THE 6.00 GeV BREMSSTRAHLUNG-INDUCED FISSION OF NATURAL URANIUM. Schroeder, B. (Univ. of Lund, Sweden). Nucl. Phys.; A197: No. 1, 88-96(1972).

The mass distribution in the 6.00 GeV bremsstrahlung-induced fission of natural uranium has been analyzed. The measured yields are shown to correspond to at least 90% of the chain yields. The results are compared with other experiments. The mass distribution curve has been decomposed into two distributions, one symmetric and one asymmetric. Finally the peak-to-valley ratio obtained is compared with results at lower irradiation energies. Good agreement is found and from the results above 1 GeV it is deduced that the total fission cross section for ^{238}U decreases rapidly with energy. (auth)

8673 HIGH-ENERGY PHOTOFISSION OF GOLD AND URANIUM. David, P.; Debrus, J.; Kim, U.; (and others) (Univ., Bonn). Nucl. Phys.; A197: No. 1, 163-76(1972).

Bremsstrahlung-induced photofission of ^{197}Au and ^{238}U has been measured for energies E_γ^{max} = 0.8 to 2.2 GeV using catcher foil techniques. The mass distributions of the fission fragments of uranium were measured as a function of the maximum bremsstrahlung energy. The peak-to-valley and forward-backward ratios have been determined for ^{238}U. (auth)

Nuclear Theory

Refer also to abstracts 8440, 8519, 8541, 8553, 8556, 8565, and 8567.

8674 (DNPL/R-20) EXTRACTION OF NEUTRON TARGET CROSS SECTIONS FROM REACTIONS ON DEUTERIUM. Daresbury Lecture Note Series No. 8. Notes Based on Lectures Given at Daresbury Nuclear Physics Laboratory, 5-7 January 1972. Julius, D. I. (Daresbury Nuclear Physics Lab. (England)). 1972. 76p. Dep. NTIS (U. S. Sales Only).

The subject is reviewed under the following heads: state vectors, scattering operators and properties of the target; dynamics of multiple scattering (the Watson multiple scattering series, the impulse approximation); the high energy region (truncation of the multiple scattering expansion, small momentum transfer experiments and the closure approximation, Fermi motion); the Glauber theory limit; specific reactions (charged pion photoproduction, neutral rho photoproduction); corrections to Glauber theory-"Fresnel" effects; large angle reactions and coincidence experiments (the multiple scattering amplitudes for coincidence measurements, final state interactions, evaluation of the coincidence cross section); and the 3-3 resonance region. (UK)

8675 (IFA-CRD-35-1968) NEUTRON CROSS SECTIONS OF EXCITED NUCLEI. Magda, M. T. (Institutul de Fizica Atomica, Bucharest (Romania)). [1968]. 12p. Dep. NTIS (U. S. Sales Only).

A method is proposed for the determination of neutron cross sections of excited nuclei. The method is based on the knowledge of level densities of a large number of medium weight nuclei as determined from spectroscopic studies. The cross section is determined from a comparison of the energy distribution of emitted particles with the corresponding statistical expression in which the level density term is replaced by the previously determined experimental level densities. Neutron cross sections were determined for excited states of ^{54}Mn, ^{55}Fe, and ^{59}Ni as an illustration of the method. (J.W.R.)

8676 (ITF-72-79-P) DIFFRACTIONAL SCATTERING THEORY. Sitenko, A. G.; Dotsenko, I. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

To describe high-energy particle scattering by nuclei one uses, as a rule, either the diffraction, or the momentum approximation as well as the momentum approximation with distortion taken into account. A comparison of the above-mentioned approximations is carried out. It is shown that the multiple scattering effects are successively taken into account in a diffraction approximation. As an example, a calculation of the differential cross sections of elastic proton scattering by C at the energies 185 and 1000 MeV is carried out in a diffraction approximation. The results agree well with experimental data. (auth)

8677 (JINR-P-6468) ANNUAL REPORT, 1971. (Joint Inst. for Nuclear Research, Dubna (USSR)). 166p. (In Russian). Dep. NTIS (U. S. Sales Only).

A survey is made of the accomplishments in 1971 of the JINR in Dubna, Russia, with pictorial representations of large bubble chambers, a synchrocyclotron and other accelerators, and similar noteworthy installations. About 17 topics in theoretical physics are described which were under study. The Lab. of High Energy reported on amplitude scattering, new resonances, the electromagnetic structure of elementary particles, relativistic nuclear physics, and two-to-many baryon systems. The Lab. of Nuclear Problems had considered particle structure, nucleon- and meson-reactions with nucleons and nuclei, and the spectroscopy of neutron-deficient nuclei. The Lab. of Nuclear Reactions submitted summary accounts of new isotope syntheses, properties of transfermium elements, the search for ultra-heavy elements in natural minerals, spontaneous fission, and heavy ion accelerators. The Lab. of Neutron Physics described its work on ultracold neutrons, alpha-decay of resonant states, fissionable and non-fissionable nuclei, nuclear reactions with charged particles, and the dynamics of condensed media. The construction of new equipment is reviewed: the completion of a synchrophasotron, a heavy ion accelerator, a neutron generator, a pulse reactor, and new computer accessories. (K.S.W.)

8678 (JINR-P4-6736) α DECAY OF HIGHLY EXCITED STATES OF DEFORMED NUCLEI. Voronov, V. V.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 13p. (In Russian). Dep. NITS (U. S. Sales Only).

The reduced probabilities for α transitions from highly excited states of deformed nuclei are obtained in the semimicroscopic approach. The results obtained are discussed and analyzed. (auth)

8679 (LBL-675) SELF-CONSISTENT TREATMENT OF PHONONS AND QUASIPARTICLES IN FINITE FERMI SYSTEMS AND APPLICATIONS TO RARE EARTH NUCLEI. Immele, John David (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 372p. Dep. NTIS. Thesis.

Using a Green's function formalism, the quasiparticle self-energy in a finite Fermi system is described in terms of the coupling of even- and odd-mass nuclear eigenmodes. The self-energy includes the usual QPC core polarization diagram, a "backwards" exchange diagram with ground state correlations, and higher order diagrams which correct for exclusion principle violations in the propagation of the quasiparticle and the microscopic phonon. Intermediate lines in the self-energy are described self-consistently, thereby including multiple-phonon core excitations. It is shown that the generalized Dyson's equation for the self-energy may be solved by matrix diagonalization rather calculated by taking into account splitting of the quasiparticle strength by QPC in the solution of the Bethe-Salpeter equation. The quasiparticle self-energy and the phonon are calculated self-consistently. The theory is used to calculate energy levels, transition probabilities, and one-nucleon transfer cross sections for even- and odd-mass isotopes in the rare earth region. An "intruder" state is predicted in the Eu and Tb isotopes. The splitting of the $K_0 \pm 2$ states in ^{165}Ho and ^{167}Er is derived from higher order contributions to the self-energy. The interference of pairing and quadrupole correlations in the ground state is discussed. An introduction to the applications of Green's function techniques in nuclear theory and an extensive review of the literature, in which the various theoretical attempts to describe low-energy properties of even- or odd-mass nuclei from the perspective of phonon and quasiparticle correlations are collated, is included. (auth)

8680 (ORO-4317-9) PRESENT STATUS OF RELATIVISTIC HARTREE-FOCK CALCULATIONS FOR NUCLEI. Technical Report 73-047. Miller, L. D. (Maryland Univ., College Park. Dept. of Physics and Astronomy). 1 Nov 1972. 41p. Dep. NTIS.

The relativistic Hartree formalism and model dependent finite nucleus calculations based upon it are reviewed. Within the model, exact results for single particle kinetic energy expectation values are compared with approximate results obtained by first order nonrelativistic reductions. The nonrelativistic approximation is found to be accurate in this model. A method for including the Hartree-Fock exchange matrix elements in the finite nucleus calculations is sketched. Numerical calculations showing the exchange effects of scalar, vector, and pseudoscalar mesons are presented. Problems in the coordinate space relativistic Hartree-Fock calculations generated by pseudoscalar meson exchange are analyzed and suggestions are made for overcoming the difficulties. (auth)

8681 (RLO-2227-T-11-2) OREGON STATE COUPLED-CHANNEL CODE. Stomp, M. J.; Schmittroth, F. A.; Madsen, V. A. (Oregon State Univ., Corvallis. Dept. of Physics). 1972. Contract AT(45-1)-2227. 186p. Dep. NTIS.

A series of computer programs, written in FORTRAN, which solve the coupled Schroedinger equations for inelastic scattering and charge-exchange reactions is described. The nuclear states may be described by a microscopic model in terms of single-particle states, a collective model (vibrational or rotational), or the Lane isospin model. Part I describes the mathematical formalism used in the solution, and Part II contains the programs themselves together with descriptions of their operation and instructions for use. (auth)

8682 TIME VARIATION OF THE COUPLING CONSTANTS. Davies, P. C. W. (Cambridge Univ., Eng.). J. Phys., A (London); 5: No. 8, 1296-1304(Aug 1972).

The possibility of the variation with time of the electromagnetic and strong coupling constants is investigated using nuclear systematics. Previous work by Dyson (1967, 1971), and Broulik and Trefil (1971), is re-examined and extended, with the conclusion that Teller's (1948) hypothesis of a logarithmic time dependence of the fine structure constant is apparently within the limits discussed if there is a corresponding logarithmic time dependence of the strong coupling constant also. Moreover the recent dis-

covery of naturally occurring ^{244}Pu places the Gamow (1967) hypothesis of $e^2 \sim t$ much nearer the allowable limits than was previously supposed. (auth) (UK)

8683 MODEL OF A RIGID NONAXIAL ROTATOR FOR ODD NUCLEI WITH A SPIN $^9/_2$. Ispailov, A. A.; Salakhitdinov, A. N.; Sharipov, Sh. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 4, 28-30(1972). (In Russian).

A simple model is proposed for investigating ground-state and anomalous rotational bands during a deflection of the form of the nucleus to 30° for odd nuclei with the spins of 9/2. A calculated (by computer) energy spectrum of the rotational states is depicted and used to compare the excited states of ^{249}Cf and ^{85}Sr. The adiabatic model of non-axial odd nuclei satisfactorily described the ground-state band as well as the anomalous bands. (K.S.W.)

8684 NUMERICAL METHOD TO CALCULATE THE EXPECTED RESONANCE STATE VALUES. Gazdy, Bela. ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 4, 201-6(1971). (In Hungarian).

The resonance states are defined as the asymptotic solution belonging to the non-negative energy of the Schroedinger equation, usually designated as Gamow states. It is shown that no quantum-mechanical internal product can be obtained with Gamow functions. T. Berggren examined this problem further, deriving laws concerning the resonance eigenstates of uncharged particles scattered by spherical symmetric potentials. It is shown that analog expressions based on the asymptotic form of Coulomb equations may be also applied to charged particles. A numerical solution was developed to integrate the Gamow functions, calculating the expected values in case of inelastic neutron scattering under consideration of the resonance states produced by spherically symmetric potential fields with a finite radius. The results were compared with those derived by means of a simple analytic model under consideration of the δ potential. It was found that excellent precision may be achieved by using the numerical method; however, the method requires considerable amount of computation and is too expensive. A new technique was recently reported in the literature, accelerating the convergence. (TTT)

8685 USE OF HIGH ENERGIES IN FOURIER ANALYSES OF ERICSON FLUCTUATIONS. Karepov, V. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 686-9(Mar 1972). (In Russian).

Spin fluctuations (Ericson, 1963) are investigated with changes in the energy of incident particles, and differential transverse cross sections of nuclear reactions, which occur with the formation of high-energy states of a compound nucleus. The treatment of four reaction cross sections was undertaken on the basis of the method: $^{27}Al(p,p')$, $^{31}P(p,p')$, $^{26}Mg(p,\alpha)$, and $^{45}Sc(p,\alpha_2)$. (K.S.W.)

8686 CALCULATION OF THE THIRD-ORDER CORRECTIONS TO THE BINDING ENERGY OF CLOSED-SHELL NUCLEI AND TO THE SINGLE-PARTICLE ENERGIES OF NUCLEI WITH ONE NUCLEON OUTSIDE A CLOSED SHELL. Kassis, N. I. (Univ. of Beirut, Lebanon). Nucl. Phys.; A194: No. 1, 205-24 (1972).

A full account of a complete third-order calculation of the binding energy of closed-shell nuclei and of the single-particle energies of nuclei with one nucleon outside a closed shell is given. The calculations, carried out by evaluating all the Feynman graphs that contribute in the space of $2\hbar\omega$ intermediate excitations for ^{16}O and ^{17}O and in the subspace of intermediate excitations up to $4\hbar\omega$ for ^4He and ^5He, show that the third-order contributions are small and of opposite sign as compared to second-order contributions. But while of relatively minor importance for the binding energies of the closed-shell nuclei considered, third-order contributions are shown to significantly affect the spin-orbit splitting of ^5He and the spin-orbit splitting and the mean l-spacing of ^{17}O. The effect of neglecting Hartree-Fock and Brueckner-type graphs is considered. (auth)

8687 DETERMINATION OF BARRIER PARAMETERS FOR THE FUSION OF NUCLEAR FRAGMENTS IN A STATISTICAL MODEL OF NUCLEAR FISSION. Protopopov, A. N.; Rubchenya, V. A.; Artem'ev, Yu. M. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 647-52(Mar 1972). (In Russian).

Within the framework of the T. Ericson statisical model (1960) and experimental data on the kinetic energy distribution in ^{235}U fission by thermal neutrons, and for a given ratio of fragment masses, barrier parameters were determined for the reverse process of fusion of the fragments. The parabolic approximation was sufficiently valid. (tr-auth)

8688 INVERSE THREE-DIMENSIONAL INTERPOLATION IN MODELS OF THE ATOMIC NUCLEUS. Begzhanov, R. B.; Belen'kii, V. M.; Usharov, V. K. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 78-82(1972). (In Russian).

The energy values of excited nuclear states in phenomenological models are found as a function of theory parameters which for a given nucleus may be determined from the experimental energies of excited nuclear states. This problem is solved by an inverse interpolation method. The number of parameters is equal to two in the majority of phenomenological models describing collective quadrupole states. However the energy and wave functions of excited states describing positive and negative parity in even-even deformed nuclei depend on three parameters. This and analogous problems are solved. (K.S.W.)

8689 CALCULATION OF ENERGY LEVELS AND DEFORMATION PARAMETERS FOR ^{166} ^{168}Er, ^{182}W, AND ^{186}Os. Bravin, A. V.; Tereshin, Yu. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 662-4(Mar 1972). (In Russian).

A general case of axially-symmetrical nuclei was examined with attention to γ vibrations, with the assumption that the deformation of the nuclear surface from its equilibrium position was not large. The calculated results were compared with experimental values of energy levels for ground and vibrational bands taken from the literature (1965 to 1970) for ^{166}Er, ^{168}Er, ^{182}W, and ^{186}Os. (K.S.W.)

8690 DETERMINATION OF MATRIX ELEMENTS OF THE LOCAL POTENTIAL ACCORDING TO THE SCATTERING PHASE AND THE SPECTRUM OF ASSOCIATED STATES. Starodubskii, V. E. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 670-3(Mar 1972). (In Russian).

Generalization and precision were imparted to the relations for finite local potentials previously developed by other workers. The desired matrix elements were expressed by means of experimentally observed quantities: phase of scattering and the spectrum of associated states. (K.S.W.)

8691 ACCURACY OF CALCULATING SHELL CORRECTIONS BY STRUTINSKY'S METHOD. Tyapin, A. S. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 665-9(Mar 1972). (In Russian).

Strutinsky's method (1966) was utilized for calculating shell corrections for statistical or the drop expression for the energy of a nucleus. Shell corrections for protons and neutrons were thus graphically depicted. (K.S.W.)

8692 POTENTIAL ENERGY FOR FISSIONABLE NUCLEI IN THE PARAMETRIZATION OF THE NUCLEAR FORM BY CASSINIAN OVALOIDS. Adeev, G. D.; Gamalya, I. A.; Cherdantsev, P. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 644-6(Mar 1972). (In Russian).

The surface potential energy of the nuclei ^{226}Ra, ^{232}Th, ^{238}U, and ^{252}Cf was calculated by Strutinsky's method (1967, 1968). The single-nucleon potential for this was selected in such form as to describe the form of the fissionable nucleus by the rotation of a smooth curve. (K.S.W.)

8693 E1-INTERNAL CONVERSION ON THE BASIS OF THE SAXON–WOODS POTENTIAL. Feresin, A. P.; Shul'ts, G.; Fainer, U. M. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 653-61(Mar 1972). (In Russian).

The effects of pair correlations and the Coriolis interaction on matrix elements of E1-internal nuclear conversion were studied on the basis of the Saxon–Woods potential. The g_k factors for the subject E1-conversion transitions were found from a comparison of theory with experiment. (tr-auth)

8694 SPONTANEOUS DECAY IN A TIME-DEPENDENT EXTERNAL FIELD. Hrasko, P. (Central Research Inst. for Physics, Budapest). Nuovo Cim.; 11B: No. 1, 13-22(11 Sep 1972).

The parametric resonance in the decay of a system such as positronium is discussed. It is shown, by means of the Wigner-Weisskopf perturbation theory, that the decay constants depend on the frequency of the external perturbation. (auth)

8695 REDUCED ROTATION MATRIX. Braithwaite, W. J. (Princeton Univ., N. J.); Cramer, J. G. Comput. Phys. Commun.; 3: No. 4, 318-21(Jul 1972).

Numerical evaluation of the rotation matrix is needed for experimental problems in atomic and nuclear physics. Examples are the use of direct reaction scattering theory to predict angular correlations between radiations and the expansion of nuclear reaction cross sections in helicity amplitudes. The DS program calculates the reduced matrix elements of finite rotations in the angular momentum representation. DS is in FORTRAN IV and was written for the IBM 360/91 computer. (J.W.R.)

8696 TEXTURE OF THE NUCLEAR SURFACE. Zafiratos, Chris D. Sci. Amer.; 227: No. 4, 100-8(Oct 1972).

The surface properties of nuclei are discussed. Several experiments offering information on the nuclear surface are reviewed. The current theoretical descriptions of surface properties of

nuclei are surveyed. The concept of alpha clustering near the surface is analyzed in detail. (J.W.R.)

8697 OPTICAL POTENTIALS FOR THE ELASTIC SCATTERING OF ^{6}Li IONS. Watson, J. W. (Texas A and M Univ., College Station). Nucl. Phys.; A198: No. 1, 129-43(1972).

Optical potentials for the scattering of ^{6}Li ions from a variety of nuclei are calculated using the Watanabe superposition model and an α + d cluster model wave function for ^{6}Li. Good fits to elastic scattering data for 20 MeV ^{6}Li ions are obtained when the imaginary wells are modified to account for absorption modes not included in the superposition model calculations. The normalization constant D_0 for direct (d,^{6}Li), (α,^{6}Li), (^{6}Li,d) and (^{6}Li,α) reactions is also calculated. The result is $D_0 = -72$ MeV·fm$^{3/2}$. (auth)

8698 ENERGY LEVELS OF ^{19}F FROM R-MATRIX ANALYSIS OF ELASTIC SCATTERING OF α-PARTICLES BY ^{15}N. Mo, T.; Weller, H. R. (Univ. of Florida, Gainesville). Nucl. Phys.; A198: No. 1, 153-60(1972).

An R-matrix analysis of the elastic scattering of α particles by ^{15}N has yielded spin and parity assignments for five levels of ^{19}F in the excitation-energy region of 7 to 8 MeV, corresponding to E_α = 3.8 to 4.8 MeV. The resonance energies and the resonance widths were also obtained. Best fits to the excitation functions at six cm angles permit spin and parity assignments of $^{7}/_{2}^{+}$, $^{7}/_{2}^{+}$, $^{7}/_{2}^{+}$, $^{5}/_{2}^{+}$ and $^{1}/_{2}^{-}$ to the levels at excitation energies of 7.12, 7.35, 7.56, 7.59 and 7.74 MeV, respectively. A previously reported $^{7}/_{2}^{+}$–$^{3}/_{2}^{+}$ doublet postulated near 7.12 MeV was not needed to account for the data in this region. A possible rotational band, which incorporates one of the three new $^{7}/_{2}^{+}$ states determined by this study, is also discussed. (auth)

8699 SHELL-MODEL HAMILTONIANS WITH GENERALIZED SENIORITY EIGENSTATES. Shlomo, S.; Talmi, I. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A198: No. 1, 81-108(1972).

The conditions on shell-model Hamiltonians which have eigenstates with generalized seniority $\nu = 0$ and $\nu = 2$ are stated and investigated in detail. For even semi-magic nuclei the conditions for $\nu = 0$ eigenstates give rise to a simple binding-energy formula with terms linear and quadratic in nucleon number. If the $\nu = 2$ conditions are also satisfied, constant spacings independent of nucleon number are obtained between ground states and the low-lying J = 2, 4, ..., levels. This feature is clearly demonstrated by the existence of a single-particle operator which transforms the $\nu = 0$ state into one with $\nu = 2$ and which obeys a linear equation of motion when acting on the $\nu = 0$ state. The constant spacings are obtained in the general case for one state with a given J, unlike the situation in the quasi-spin scheme in which there are n-independent separations between all levels. Examples are given of cases in which these conditions are actually fulfilled and yet in which the eigenstates are not those of the quasi-spin formalism. (auth)

8700 SOME COMMENTS ON PERTURBATION THEORY. Nissimov, H.; Elliott, J. P. (Univ. of Sussex, Eng.). Nucl. Phys.; A198: No. 1, 1-10(1972).

It is shown how, with no significant extra effort, the results of a third-order perturbation calculation may be used to calculate a least upper bound to the energy. Examples suggest that this bound is a better approximation than the usual perturbation series to third order. When only second-order calculations are made it is shown how a modified formula gives a much better approximation than the usual series to second order, again with no significant extra effort. (auth)

8701 FBCS FOR ODD NUCLEI AND THE INVERSE GAP EQUATIONS: APPLICATION TO N = 50 ISOTONES. Allaart, K.; Boeker, E. (Vrije Univ., Amsterdam). Nucl. Phys.; A198: No. 1, 33-66(1972).

The single-quasiparticle descriptions of odd superfluid nuclei by BCS theory and by particle number projection methods are compared with the exact lowest-seniority shell model. The purpose is to trace systematic inadequacies of the inverse-gap-equations (IGE) method to extract single-particle energies from spectroscopic data on odd nuclei and to improve that method by using number projection techniques. The IGE method yields too large a spacing of single-particle energies especially near closed subshells and also the force strengths are not correctly given in general. A similar method based on particle number projection leads to correct results. A conventional two-quasiparticle BCS calculation of the spectra of even nuclei with parameters obtained by the IGE method leads to other results than when for both the odd and the even nuclei a number-conserving description is used. In the former approximation particle-hole like states are relatively too high and particle–particle or hole–hole like states too low in energy, which may strongly influence the configuration mixing. As a practical application the spectra and a few other spectroscopic properties of the even single-closed-shell nuclei with 50 neutrons are calculated. (auth)

8702 POSSIBILITY OF SECOND-CLASS CLASS CURRENTS IN GAMOW–TELLER β-DECAY. Wilkinson, D. H. (Univ. of Washington, Seattle). Proc. Roy. Soc. Edinburgh, Sect. A; 70: 307-26(1972).

Mirror Gamow–Teller β-decay takes place from members of isospin multiplets to a common final state or to final states that are mirrors of each other. It is found that in these cases the intrinsic speed of the positon emission is systematically lower, by 10 to 15% than that of the mirror negaton emission. This difference could be due to a fundamental weak interaction effect, a second-class term in the weak hadronic current, or to a failure of exact symmetry in the nuclear structure. The influence of binding energy differences is studied in the latter context and it is concluded that they cannot be responsible for the empirical asymmetry. The effects of changes of configurational mix across the multiplets is also considered; very few estimates have been explicitly made but it would be surprising if this effect turned out to be of constant sign and magnitude over the wide range of A involved. No present firm conclusion can be made but none of the empirical evidence is inconsistent with the reality of a largely momentum-transfer-independent second-class current. (auth)

8703 COMMENTS ON TERNARY FISSION: POST-SCISSION α-PARTICLE EMISSION. Vass, D. G. (Univ. of Edinburgh). Proc. Roy. Soc. Edinburgh, Sect. A; 70: 295-306(1972).

The possibility of α-particle emission from fully accelerated fission fragments is considered. The results of trajectory calculations for such α-particles emitted during the fission of ^{252}Cf are presented, and their significance in relation to the observed energy and angular distributions of the α-particles is discussed. (auth)

8704 LEVEL-DENSITY FLUCTUATIONS AND TWO-BODY VERSUS MULTI-BODY INTERACTIONS. Wong, S. S. M. (Univ. of Toronto); French, J. B. Nucl. Phys.; A198: No. 1, 188-208 (1972).

The level density, as calculated from many-particle spectroscopic matrices, is sensitive to the p-body nature of the interaction, changing from an approximately Gaussian form for 2-body interactions to the Wigner semi-circular form when all the particles interact simultaneously (as happens in the random-matrix realization of the matrices). The difference, non-local in energy, is however not usable for investigating the "particle rank," p, of the interaction, since in actual nuclei the restricted density cannot be realized over a wide enough energy range to define its non-local behavior. One is then led to ask whether the (local) level-density fluctuations, which are observed mainly in slow-neutron spectroscopy and which are usable in searching for hidden symmetries, can be used also in deciding whether the interaction is predominantly 2-body or multi-body. The fluctuations produced by Gaussian orthogonal ensembles (GOE) of finite-dimensional matrices (dimensionalities 50 and 294) have been compared with those produced by corresponding ensembles defined by 2-body interactions, as well as with results of recent very large shell-model calculations (dimensionalities 500 to 1200) and recent experiments. Comparison is made by means of the spacing distributions of various orders, the nearest-neighbor-spacing covariance, and the long- and short-range-order statistics of Dyson and Mehta. The fluctuations are found to be essentially identical for all cases, and to agree with theoretical GOE results where such are available. It appears then that the results of conventional random-matrix theory apply under very general conditions, but the physical information which is carried by the level-density fluctuations alone seems to be quite meager. (auth)

8705 PHENOMENOLOGICAL CAUSAL MODEL OF NUCLEAR DECAY, ASSUMING INTERACTION WITH NEUTRINO SEA. Dudley, H. C. (Univ. of Illinois, Chicago). Lett. Nuovo Cim.; 5: No. 3, 231-2(16 Sep 1972).

The possibility that constant logarithmic rates for nuclear decay results from an equilibrium energy exchange with a neutrino sea is discussed. Analysis of changes in rates of ^{133}Cs clocks flown around the Earth in jet aircraft indicates that the energy equilibrium is altered by the change in effective velocity with respect to the neutrino sea. It is postulated that populations of nuclei undergoing spontaneous decay consist of units each of which is a linear resonant system. Parametric excitation of such units may cause the systems to react to reduce the effects of the extraneous force. (J.W.R.)

8706 IMPROVED DENSITY- AND MOMENTUM-DEPENDENT DELTA-FUNCTION INTERACTION. Lassey, K. R. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A192: No. 1, 177-99 (1972).

It is shown how to generate a family of density- and momentum-

dependent δ-function effective interactions, with members differing only in their nuclear-matter incompressibilities, by demanding a fit to the saturation and symmetry properties of nuclear matter, and to the surface properties of semi-infinite nuclear matter. Useful interactions are isolated, and two of them are used in model calculations with ^{16}O and ^{40}Ca, and compared with similar interactions, developed by Moszkowski and by Vautherin and Brink. The limitations of this type of interaction are discussed. (auth)

8707 TRANSITION FROM SHELL STRUCTURE TO COLLECTIVE BEHAVIOR. A SIMPLIFIED SHELL-MODEL STUDY. Hecht, K. T. (Univ. of Michigan, Ann Arbor); McGrory, J. B.; Draayer, J. P. Nucl. Phys.; A197: No. 2, 369-409(1972).

To study the feasibility of carrying out shell-model calculations in nuclei with active protons and neutrons in different major shells, the following simple idealized model has been studied: (i) Proton and neutron configurations are chosen to be $(f_{\frac{7}{2}}p_{\frac{3}{2}}p_{\frac{1}{2}})^n_p$ and $(g_{\frac{9}{2}}d_{\frac{5}{2}}d_{\frac{3}{2}}s_{\frac{1}{2}})^n_n$, so that results for the separate proton and neutron basis states to be used in any approximation scheme can be compared with the results for exact shell-model calculations. (ii) The proton and neutron single-particle energies for these active shells are separately taken to be degenerate. (iii) The two-body interaction is approximated by the simple surface delta interaction (SDI). To effect the severe truncation of the full shell-model space needed to make such a shell-model study possible the separate proton and neutron parts of the shell-model basis are built from a superposition of the favored pair states of the SDI (with $J \neq 0$, as well as $J = 0$). In the neutron configuration $(g_{\frac{9}{2}}d_{\frac{5}{2}}d_{\frac{3}{2}}s_{\frac{1}{2}})^{n_n=4}_n$, for example only three of the 94 shell-model states with $J_n = 2$ are retained in the truncation scheme. In this highly truncated basis both the energies and the strong B(Ek) values for the transitions from these states to similar favored states with other J-values are within a few percent (or better) of the results of exact shell-model calculations. A truncation of the shell-model space based on such superpositions of favored pair states leads to a manageable shell-model basis (dimensions ≤ 200). (a) The number of states in the separate proton and neutron parts of the basis are small enough (8–13 for the proton space, 15–30 for the neutron space). They are also the key states in the following sense. (b) They include the low-lying energy eigenstates of the separate p-p and n-n parts of the interaction. (c) They contain most of the collective coherence of the separate proton and neutron configurations. (d) The matrix elements of the n-p part of the interaction between the favored states are in general very large compared with the matrix elements between a favored and an excluded state. The latter effect is studied from several aspects, in particular in terms of sum rules for the matrix elements of the surface multipole operators from which the n-p part of the SDI is built. For most of the low-lying favored states the sum over all favored states gives more than 90% of the total sum rule for the squares of matrix elements of the surface multipole operators. The results of shell-model calculations in this truncation scheme, with $n_p = 4$ or 6, and $n_n = 4$, show many of the features of a quadrupole vibrational spectrum. The presence and exact nature of a 0^+ member of the 0^+, 2^+, 4^+ "two-phonon triplet" is dependent on the inclusion of the key favored states with seniorities of 6. (auth)

8708 SINGULARITIES OF THE GENERATOR-COORDINATE AMPLITUDE FOR SCATTERING. Giraud, B.; Letourneux, J. (Univ. of Montreal). Nucl. Phys.; A197: No. 2, 410-16(1972).

It is shown that the high-frequency catastrophe which plagues generator-coordinate calculations is a finite-range distribution. This finite range allows standard numerical procedures matching an internal solution with an asymptotic external wave. (auth)

8709 PION–^{12}C ELASTIC SCATTERING IN THE $(\frac{3}{2},\frac{3}{2})$ RESONANCE REGION. Schmit, C. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A197: No. 2, 449-84 (1972).

The optical model derived from Watson's multiple scattering theory is applied to the analysis of the π–^{12}C elastic scattering around the $(\frac{3}{2},\frac{3}{2})$ resonance. In this energy range, the validity of the approximations used in the Kisslinger model is dubious and our aim is to avoid them. Thus we make some corrections to the impulse approximation and show that one can separate the nucleon binding effect from the effect of the Pauli principle in the π-nucleon transition matrix in nuclear matter. In the evaluation of the optical potential we use a parametrization of the π-nucleon transition matrix close to the form given by the Chew–Low model. The first-order term is calculated correctly by taking into account Fermi motion and using the correct kinematics, whereas the second-order term is evaluated using the static and closure approximations. The results obtained show that the impulse, static and even the coherent scattering approximations are not justified in this energy range. However there still remains a discrepancy between our results and the experimental ones. (auth)

8710 DEFORMATION OF THE OXYGEN HEAVY IONS IN A MOLECULAR DESCRIPTION OF THE $^{16}O + ^{16}O$ SYSTEM. Reidemeister, G. (Univ., Brussels). Nucl. Phys.; A197: No. 2, 631-40(1972).

A microscopic description of the system formed by two interacting ^{16}O nuclei is presented. The total wave function is a Slater determinant built up with the molecular orbitals of a two-center shell model. The deformation of the nuclei due to their nuclear interaction is determined through a variational calculation. This calculation suggests the existence of a very deformed prolate state in ^{32}S. (auth)

8711 COLLECTIVE ROTATIONS IN PARTICLE INDEX SPACE. Morinigo, Fernando B. (California State Univ., Los Angeles). Nucl. Phys.; A192: No. 1, 209-17(1972).

A canonical transformation expresses the kinetic energy of n particles of equal mass in terms of nine collective coordinates. Six coordinates are angles: a set of three Euler angles of ordinary rotations and a set of three Euler angles derivable from matrices that describe rotations in particle index space. The remaining three coordinates are the square roots of the instantaneous eigenvalues of the mass quadrupole tensor. The angular dependence of the kinetic energy is expressible in terms of angular-momentum-type operators. The square of the particle index rotation analog of the orbital angular momentum, and any component, are constants of the motion in the problem of n particles in an oscillator well perturbed by quadrupole forces. The new coordinates and quantum numbers are used in finding the collective eigenfunctions in the problem of the planar motion of particles in an oscillator well perturbed by quadrupole two-body forces. The conserved quantum number of particle index rotations serves to define rotational bands. A first-order calculation yields the coefficient of an energy correction proportional to the square of the angular momentum. (auth)

8712 NONLOCAL AND MAJORANA EXCHANGE TERMS IN THE OPTICAL MODEL. Greenlees, G. W.; Makofske, W.; Tang, Y. C.; Thompson, D. R. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 6: No. 6, 2057-64(Dec 1972).

The suggestion that nonlocal terms arising from the effects of antisymmetrization in light systems should be present in heavier systems is examined. The introduction of one such term into the optical potential for proton–nucleus scattering produces significant effects at backward angles. It is shown that these nonlocal effects can be represented almost exactly by the introduction of a Majorana component into the real central potential. The results are applied in an analysis of data from 30-MeV proton elastic scattering by ^{40}Ca. (6 figures) (auth)

8713 TWO-STEP PROCESSES IN STRIPPING REACTIONS. Bindal, P. K.; Koshel, R. D. (Ohio Univ., Athens). Phys. Rev., C; 6: No. 6, 2281(Dec 1972).

A formalism was developed for the inclusion of two-step processes in one-particle transfer reactions on deformed nuclei. Calculations for the $^{24}Mg(d,p)^{25}Mg$ and $^{182}W(d,p)^{183}W$ reactions show that the two-step processes are very important for the weakly excited and forbidden transitions; however, for the transitions that are strongly allowed in the one-step process, the effect is small. Calculations for the $^{24}Mg(d,p)^{25}Mg$ ($\frac{7}{2}^+$, 1.61 MeV) and for the $^{182}W(d,p)^{183}W$ ($\frac{1}{2}^-$, g.s.) reaction show that the two-step process via inelastic scattering in the entrance channel is about equal to the two-step process via inelastic scattering in the exit channel. Good fits with the experimental data are obtained. (11 figures, 2 tables) (auth)

8714 ANOMALOUS EXCITED K = 0 ROTATIONAL BANDS IN HEAVY NUCLEI. Das Gupta, S. (McGill Univ., Montreal); Volkov, A. B. Phys. Rev., C.; 6: No. 5, 1893-6(Nov 1972).

It is proposed that in the region of two-quasi-particle excitations there exist K = 0 rotational bands such that: (a) $K\pi = 0+$ occurs with only odd J values; and (b) $K\pi = 0-$ occurs with only even J values. Properties of such anomalous bands are investigated. (auth)

8715 LEVEL DENSITIES FROM ANALYSIS OF PARTICLE SPECTRA. Vaz, L. C.; Lu, C. C.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Phys. Rev., C.; 6: No. 5, 1896-7(Nov 1972).

The analysis of particle-evaporation spectra with the approximate theory, which neglects angular momentum, leads to ambiguous values of the level-density parameter, a. This ambiguity can be removed by using the exact theory, which explicitly includes angular momentum. (1 table) (auth)

8716 DIRECTIONAL CORRELATION OF L X RAYS AND γ RAYS IN NUCLEAR ELECTRON CAPTURE AND INTERNAL CONVERSION. Rupnik, Tomaz; Crasemann, Bernd (Univ. of Oregon, Eugene). Phys. Rev., C.; 6: No. 5, 1780-9(Nov 1972).

Dolginov's theory of directional correlations between x rays and

γ rays emitted after nuclear electron capture is reviewed, simplified in the light of recent advances, and extended to second-forbidden nonunique transitions. Specific predictions are derived for directional correlations between Pb L x rays and γ rays emitted following second-forbidden electron capture and M4 γ-ray internal conversion in ^{207}Bi decay. No average anisotropy was found in a measurement of the directional correlation between Ll + Lα + Lβ x rays and 570-keV γ rays from ^{207}Bi; the result is $A = (2 \pm 2) \times 10^{-3}$. Suggestions for further work are offered. (4 figures, 2 tables) (auth)

8717 HIGHER-ORDER TERMS IN THE VARIABLE-MOMENT-OF-INERTIA MODEL. Varshni, Y. P.; Bose, S. (Univ. of Ottawa). Phys. Rev., C.; 6: No. 5, 1770-80(Nov 1972).

The variable-moment-of-inertia model for the ground-state rotational bands in even–even nuclei was extended by adding an anharmonic term to the potential energy. A detailed application of this model, called VMI23, was produced to the ground-state bands of 122 even–even nuclei. It is shown that the inclusion of the anharmonic term improves agreement with the experimental data in many cases, and provides a sensitive means of probing the potential energy surfaces of nuclei. (1 figure, 3 tables) (auth)

8718 MUON ABSORPTION BY NUCLEI WITH N > Z. Joseph, J. (Univ., Lyon); Ledyen, F.; Goulard, B. Phys. Rev., C.; 6: No. 5, 1742-55(Nov 1972).

Muon absorption is investigated for nuclei with an excess of neutrons in order to answer the questions: Are the studies carried out in previous works on N = Z nuclei valid for a larger class of nuclei with N > Z and possibly heavier? If so, to what extent? The present study indicates that the conventional shell-model techniques yield similar results for a more complex class of nuclei. Several selected nuclei are taken as examples; the ^{88}Sr nucleus is thoroughly studied. (1 figure, 8 tables) (auth)

8719 GEL'FAND–LEVITAN-UNITARITY-TRANSFORM FORMALISM FOR DIRECT EXTENSION OF THE TWO-NUCLEON T MATRIX OFF THE ENERGY SHELL. Picker, H. S. (Univ. of Maryland, College Park); Lavine, J. P. Phys. Rev., C.; 6: No. 5, 1542-52(Nov 1972).

The unitary-transform method of Coester et al. is modified, for uncoupled partial waves in which there are no bound states, so that empirical phase shifts rather than a potential fitted to them may be used as the basic input. This is accomplished by invoking the Gel'fand–Levitan inverse scattering formalism to generate a complete orthonormal set of scattering wave functions from the phase shifts. The result is a convenient formal framework for analyzing the uncertainties in the off-energy-shell behavior of the two-nucleon interaction. Variations in the off-energy-shell T matrix arising from changes in the phase shifts, as well as those due to different short-range nonlocalities, may be studied directly by using the method presented. (auth)

8720 K-MATRIX THEORY OF NUCLEAR FORM FACTORS. Tobocman, W. (Case Western Reserve Univ., Cleveland). Phys. Rev., C.; 6: No. 5, 1553-9(Nov 1972).

A method of constraining a shell-model-type nuclear bound-state calculation to give wave functions that display physical asymptotic behavior is derived and subsequently used to get an expression for the nuclear form factor. In this method one seeks the poles of the collision matrix rather than the eigenvalues of the Hamiltonian. The method is compared with that of Lane and Robson, that of Pinkston and Satchler, and that of Nagarajan and Tobocman. (auth)

8721 (p,2p) REACTIONS WITH DIVERS POTENTIALS. Stephenson, G. J. Jr. (Univ. of Maryland, College Park); Redish, E. F.; Lerner, G. M.; Haftel, M. I. Phys. Rev., C.; 6: No. 5, 1559-64(Nov 1972).

The p–p cross sections relevant to a factorized-impulse-approximation treatment of (p,2p) reactions from 150 to 350 MeV are calculated. Several on-shell prescriptions are used and compared with the half-off-shell prescription suggested by the Faddeev–Watson multiple-scattering series. Four phenomenological potentials, Hamada–Johnston, Bryan–Scott III, Reid hard-core, and Reid soft-core, are investigated as well as three potentials which are phase-shift equivalent to the Reid soft-core potential. Significant differences are found between the various prescriptions for all of the potentials. A wide range in the predictions on the various phenomenological potentials for each prescription is also observed. However, the ratio of the half-shell cross section to the on-shell cross section is remarkably insensitive to the choice of potential, especially where the half-shell prescription is needed. This result suggests a simple method for extrapolating from the elastic scattering data to the appropriate half-shell cross section. (5 figures, 1 table) (auth)

8722 PROBLEM OF ANTISYMMETRIZATION IN HEAVY-ION SCATTERING. Park, J. Y. (North Carolina State Univ., Raleigh); Scheid, W.; Greiner, W. Phys. Rev., C.; 6: No. 5, 1565-93(Nov 1972).

A general formalism for the scattering of heavy ions, which is especially convenient to study the antisymmetrization effects, is developed. Antisymmetrization effects are investigated by expanding the completely antisymmetrized wave function according to the number of exchanged nucleons. The particle–core model for the scattering of nuclei with loosely bound nucleons is presented. A formula for the additional contribution to the effective potential due to antisymmetrization effects is obtained by calculating the expectation value of the Hamiltonian with intrinsic wave functions. Application of the formalism is illustrated for the ^{14}N + ^{14}N scattering problem, and its usefulness is demonstrated. (11 figures, 3 tables) (auth)

8723 PAULI PRINCIPLE AND THE LINKED CLUSTER EXPANSION FOR THE NUCLEAR OPTICAL POTENTIAL. Ernst, D. J. (Instituto Politecnico Nacional, Mexico City). Phys. Rev., C.; 6: No. 5, 1522-5(Nov 1972).

A linked cluster expansion is derived for the nuclear optical potential which includes already in lowest order, in addition to the Hartree–Fock potential, a term which has recently been shown to be large for nucleons scattering from light nuclei. It is shown that this additional term reproduces effects of the Pauli exclusion principle. (1 figure) (auth)

8724 PARAMETRIZATION OF THE THREE-BODY D FUNCTION. II. Adhikari, S. K.; Amado, R. D. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C.; 6: No. 5, 1484-95(Nov 1972).

A new parametrization of the three-body D function based in part on numerical investigation is presented. It is correct in both weak coupling and the Efimov limit, and agrees remarkably well with "exact" numerical calculation in a boson model. It has the correct singularity position but not the correct strength at the three-body threshold. In the neutron–deuteron quartet system it agrees very well with exact calculation and casts light on the relative model independence of these calculations. It is also shown that the Efimov states become virtual states with increasing coupling. (4 figures, 1 table) (auth)

8725 δ-FUNCTION MODEL FOR THE TWO-NUCLEON INTERACTION. Aviles, J. B. Jr. (Naval Research Lab., Washington, D. C.). Phys. Rev., C.; 6: No. 5, 1467-84(Nov 1972).

An interaction of the form $V_{LJST}(r) = \Sigma\,(v_i/r_i)\delta(r - r_i)$ is used to make a fit to the Livermore X phase shifts (0 to 460 MeV). Only states with $L \leq 2$ are considered; coupling between states is at present neglected, but effective central $^3S_1$ and $^3D_1$ interactions are given. No more than four terms (per state) are required. In states which have a repulsion the position of the innermost δ function can be chosen arbitrarily within wide limits; e.g., for the $^1S_0$ state $0.1542 \leq r_1 \leq 0.95$ F. Families of hard-core interactions in which r_c and r_1 are arbitrary are also determined. $0.1542 \leq r_c \leq 0.7$ F is found for the $^1S_0$ state. All $^1S_0$ interactions give essentially the same D-state phase shifts within the same energy range (these differ from $^1D_2$ experimental phase shifts). The main virtues of this type of potential are the ease with which the parameters may be determined and its relative simplicity in calculations for $A \geq 3$ and nuclear matter. It may also be written in the separable form $\langle rLJST|V|r'LJST\rangle = \Sigma\,(v_i/r_i)\delta(r - r_i)\delta(r' - r_i)$. (12 tables) (auth)

8726 RESONANCE REACTIONS AND THE ENERGY DEPENDENCE OF NEUTRON WIDTHS. Tindle, C. T. (Univ. of Auckland, New Zealand). Phys. Lett.; 42B: No. 1, 5-7(13 Nov 1972).

The different energy dependence of resonance level widths in the R- and S-matrix theories of resonance reactions is shown to be undetectable in experimental data. It is concluded that, from the viewpoint of their ability to fit experimental data, the two theories are equivalent. (auth)

8727 REDUCED EXPRESSION OF CLEBSCH–GORDAN COEFFICIENTS. Sato, M.; Kaguei, S. (Yokohama National Univ., Japan). Phys. Lett.; 42B: No. 1, 21-3(13 Nov 1972).

It is shown that the general formula of Clebsch–Gordan coefficients can be reduced into a binomial expansion in a symbolical sense in an analogous way to that of Racah coefficients given by Sato. (auth)

8728 HIGHER PARTIAL WAVE CONTRIBUTION TO NUCLEAR MATTER BINDING ENERGY: PHASE SHIFT APPROXIMATION VERSUS ONE PION-PLUS σ-EXCHANGE POTENTIAL. Grange, P.; Preston, M. A. (McMaster Univ., Hamilton, Ont.). Phys. Lett.; 42B: No. 1, 35-7(13 Nov 1972).

The contribution to nuclear matter binding energy of states with $J \geq 3$ is estimated from the "OPEP + σ" model and is compared with the previously used OPEP model and phase-shift approximation. Results are respectively 0.99, 2.22, and 0.77 MeV per parti-

cle at $k_F = 1.36$ fm^{-1}, a good improvement over the simple OPEP treatment. (auth)

8729 STATISTICAL MODEL OF NUCLEI AND ITS RELATION TO THE STRUTINSKY AVERAGING METHOD. Gross, D. H. E. (Hahn-Meitner Institut fuer Kernforschung, Berlin). Phys. Lett.; 42B: No. 1, 41-4(13 Nov 1972).

The generalized Thomas–Fermi model (statistical model) of nuclei including higher-order nonhomogeneity corrections for the kinetic energy is derived from the time-(temperature-)dependent Green's function in the limit of small t (high T). The Weizsaecker correction term is derived in a straightforward manner to be $\frac{1}{9}(\hbar^2/8m)(\nabla\rho)^2/\rho$. A method of including shell structures approximately is presented. The equivalence of the statistical model with the Strutinsky prescription is demonstrated analytically. (auth)

8730 EXOTIC MUON CAPTURE IN NUCLEI AND LEPTON CONSERVATION. Shuster, M. D.; Rho, M. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 42B: No. 1, 45-8(13 Nov 1972).

The process $\mu^- + {}^A\!Z \rightarrow e^+ + {}^A\!(Z-2)$ is considered in connection with the lepton scheme of Konopinski and Mahmoud. An upper limit for the isotensor weak coupling constant is determined which is smaller than that previously obtained by Kisslinger. The possible connection with recent attempts to discover an isotensor electromagnetic interaction is also discussed. (auth)

8731 PHOTON-INDUCED NUCLEAR REACTIONS ABOVE 1 GeV. II. SPALLATION REACTIONS. Lindgren, K.; Jonsson, G. G. (Lund Inst. of Tech., Sweden). Nucl. Phys.; A197: No. 1, 71-80(1972).

Previously reported studies on spallation reactions in I and Au at intermediate energies have been extended to the GeV region. The yield and cross-section distributions in iodine are analyzed with the five-parameter formulas given by Rudstam and the values of the parameters obtained are discussed. At intermediate energies, some Monte Carlo calculations based on the cascade-evaporation model have been carried out and agreement between calculations and experiment is obtained. The experimental (γ,xn) cross sections in gold are compared to estimates from the Rudstam CDMD formula. (auth)

8732 ACCURACY OF THE UNITARY POLE APPROXIMATION FOR THE REID TRIPLET POTENTIAL. Siebert, B. (Rensselaer Polytechnic Inst., Troy, NY); Levinger, J. S.; Harms, E. Nucl. Phys.; A197: No. 1, 33-43(1972).

The unitary pole approximation (UPA) has been shown to be quite accurate for a central attractive potential with a soft core, such as the Reid singlet potential. Its accuracy for the Reid triplet soft-core potential, which includes tensor and spin-orbit forces, is examined. UPA values for the t-matrix $t_{LL'}(p, k; s)$ are compared with Haftel's numerical values. Here L and L' are angular momenta, either 0 or 2. The momenta are p and k, and negative energy s. It is found that the UPA fits Haftel's values for t_{00} about as well as the UPA fits for the Reid singlet. The UPA is less successful for t_{02} and t_{22}, but in general it fits Haftel's values better than does the Yamaguchi t-matrix. (auth)

8733 COEXISTENCE OF QUADRUPOLE AND OCTUPOLE VIBRATIONS IN ^{145}Sm. Vanden Berghe, G. (Rijksuniversiteit, Ghent); Waroquier, M. Nucl. Phys.; A196: No. 2, 303-11(1972).

The level scheme of ^{145}Sm is calculated in a particle-core coupling model. Spectroscopic factors for (d,p) reactions are calculated and compared with the experimental data. Branching ratios for γ-rays decaying from the $I^\pi = 3/2^+$ positive-parity state are discussed. Partial decay widths from the isobaric analog resonances, excited in the ^{144}Sm(p,p') reaction to the first excited 2^+ state, are calculated. (auth)

8734 OFF-SHELL EFFECTS IN NUCLEON-EXCHANGE REACTIONS. Cattapan, G.; Vanzani, V. (Univ., Padua). Nuovo Cim.; 12A: No. 2, 297-320(21 Nov 1972).

Nucleon-nucleus rearrangement reactions proceeding via a nucleon-exchange mechanism are investigated in the framework of a three-body model. Starting from the Alt, Grassberger and Sandhas representation for the transition operators, we derive, by means of a suitable operator multiplier technique, an uncoupled integral equation showing in the inhomogeneous term the role of the nucleon–nucleon off-energy-shell t-matrix. The knock-out triangular diagram amplitude involving the off-energy-shell t-matrix is compared with the corresponding amplitude in the Born approximation for the t-matrix. The results show that the knock-out amplitude is rather sensitive to the off-shell behavior of the two-nucleon interactions. (auth)

8735 ANGULAR-MOMENTUM BASIS FOR A GENERAL j^n CONFIGURATION. Patera, J. (Univ. of Montreal); Sharp, R. T. Nuovo Cim.; 12A: No. 2, 365-76(21 Nov 1972).

A method, not recursive in any way, is described for specifying and calculating angular-momentum basis states for the general j^n configuration. The states are given in terms of Gel'fand patterns of SU_{2j+1}. Some examples are worked out. (auth)

8736 ASYMMETRY OF DIRECT NEUTRON EMISSION IN POLARIZED-MUON CAPTURE. Madurga, G. (Univ., Barcelona). Nuovo Cim.; 12A: No. 2, 451-64(21 Nov 1972).

The rate and angular distribution of knock-on neutrons in polarized-muon capture by spinless nuclei is calculated in a simple statistical model, and compared with experimental data and other calculations. (auth)

8737 EFFECTIVE INTERACTIONS AND 2p–2n SYSTEMS IN THE (f,p) SHELL. Richert, J. (CRN, Strasbourg). Nuovo Cim.; 12A: No. 2, 480-90(21 Nov 1972).

This paper deals with the determination of an effective interaction for shell model calculations in the (f,p) shell. The interaction consists of two parts. The first one is determined from a realistic nucleon–nucleon potential, the second is a tensor-force ansatz acting at the surface of the nucleus. Justifications for the use of this ansatz are given. The parameters appearing in the interaction are fixed by considerations on single-particle energy splittings. The matrix elements are used in a spectroscopic study of ^{44}Ti and ^{60}Zn. A certain number of E2 transitions rates are evaluated. The agreement with former studies is shown to be good. Wave functions are analyzed and comments about the link between model space and effective interaction are made. (auth)

8738 PION–NUCLEUS SCATTERING: THEORY. Wilkin, C. (University Coll., London). pp 2.1-24 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The validity of the various potentials commonly used in theoretical calculations on the energy scattering of pions by nuclei is discussed. The singularities of the Kisslinger potential and the local potential are examined. The results obtained using the Glauber theory for the self-correlations are considered. (6 figures) (France)

8739 CORRECTIONS TO THE IMPULSE APPROXIMATION AND TO THE KISSLINGER MODEL IN THE SCATTERING OF π MESONS ON NUCLEI. Schmit, C. (Paris Univ., Orsay, France) pp 2.61-70 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The static, impulse, and coherent scattering approximations used in the optical model calculations are shown not to be justified in the $(3/2,3/2)$ resonance region. An analysis of the π^- ^{12}C scattering at 180 MeV is presented as an example. (3 figures) (France)

8740 DOUBLE-CHARGE-EXCHANGE SCATTERING OF PIONS BY NUCLEI. Reitan, A. (European Organization for Nuclear Research, Geneva). pp 3.1-13 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

The various mechanisms which have been suggested for double charge exchange reactions are reviewed (Shapiro diagram, the Kohmura model, the Barshay and Brown theory, the Glauber theory, the cascade theory). The elementary particle aspects and the nuclear physics aspects of double exchange reactions are successively considered. (France)

8741 NONRADIATIVE PION ABSORPTION ON NUCLEI (THEORETICAL). Locher, M. P. pp 5.1-15 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Commonly accepted theories on the nonradiative absorption of pions by nuclei are reviewed and some new trends (particularly experimental trends) are presented: basic modes and cluster absorption; theoretical ideas on rescattering and final-state NN interaction; representation of rare modes as (p,π^+) or (π^+,p) quasi-two-body processes. (14 figures) (France)

8742 CALCULATIONS OF MESONIC CONTRIBUTIONS TO (γ,n) REACTIONS. Andersson, G.; Forkman, B.; Friberg, B. (Univ. of Lund, Sweden). pp 5.126-9 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Photonuclear reactions were studied in the 100–1000 MeV energy range. It is postulated that the photon interacts with a single neutron inside the nucleus and that a single or double pion production process takes place. The cross section calculated for a $^{12}C(\gamma,n)$ reaction using the impulse approximation is given. (France)

8743 MECHANISMS AND THEORETICAL PROBLEMS. Faeldt, Goeran (Univ. of Lund, Sweden). pp. 6.1-11 of Proceedings of the International Seminar on π Meson–Nucleus Interactions. Strasbourg; Universite Louis Pasteur (1971).

From International seminar on pion–nucleus interactions; Strasbourg, France (20 Sep 1971). See CONF-710948.

Theoretical descriptions of pion–nucleus scattering at low energies are presented. The following problems are discussed: the accuracy of the impulse approximation, the relations between different potentials, the off-shell effects in the Kisslinger potential model, and the validity of the Glauber model and other approaches. (France)

PHYSICS (PLASMA AND THERMONUCLEAR)

8744 (IPP–1/127) PROCEEDINGS OF THE SECOND TOPICAL CONFERENCE ON PULSED HIGH-BETA PLASMAS, 3–6 JULY 1972. Lotz, W. (ed.) (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jul 1972. 281p. (CONF-720710). Dep. NTIS (U. S. Sales Only).

Separate abstracts were prepared for 57 of the included papers. For abstracts of the remaining 7 papers see CONF-720710 in the report number index. (M.O.W.)

For abstracts of individual papers see: 8748–8759, 8769, 8770, 8777, 8778, 8786–8791, 8795–8800, 8806, 8810–8824, 8834–8845, and 8854.

Confinement and Heating

Refer also to abstract 8807.

8745 (CEA-N–1546) TOKAMAK-2 PROBLEM. Boujot, J. P.; Meurant, G.; Saussais, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1972. 76p. (In French). Dep. NTIS (U. S. Sales Only).

A numerical integration method for treating the system of equations governing the spatio-temporal evolution of a plasma in a Tokamak-type configuration is defined. The model adopted corresponds to the two-fluid magnetohydrodynamic equations in an approximation possessing cylindrical symmetry of revolution. The practical realization of the program (particularly, the conversational visual display of the results with a graphic terminal) is also described. (France)

8746 (EUR-CEA-FC–656) DIFFUSION IN ECRH MAGNETIC MIRRORS. Lichtenberg, A. J.; Melin, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1972. 22p. Dep. NTIS (U. S. Sales Only).

A theory of electron cyclotron resonance heating (ECRH) in a mirror device, is applied to the rf induced particle diffusion into the loss cone. It is shown that the loss time is much less than the heating time within the stochastic heating region, but that such losses are much greater than those due uniquely to collisions. The effects of collisions in combination with the ECRH are examined and it is shown that they give additional heating beyond the adiabatic barrier (on the time scale of the 90 deg collisional deflection). The collisions also act in conjunction with the rf fields to enhance the rate of loss cone diffusion. The principal assumptions and the results of the theory are confirmed by exact numerical calculations. Predictions of the performance of the CIRCE 25kW ECRH experiment are made. (France)

8747 (EUR-CEA-FC–657) LOWER HYBRID PLASMA HEATING. Pesic, S. S. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1972. 40p. Dep. NTIS (U. S. Sales Only).

The damping of quasi-longitudinal plasma oscillations in the lower hybrid frequency range was investigated. The complete dispersion equation governing small-amplitude quasi-longitudinal oscillations in hot homogeneous anisotropic plasmas was solved numerically for a wide range of plasma parameters. The temporal damping rates of stable eigen oscillations and the spatial damping rates of externally driven plasma waves are given. The lower hybrid dispersion curves are presented. The straight-line orbit approximation, the effect of distant collisions on the ion resonant interaction, and the limits of linearity imposed by the distortion of the distribution function in the resonant velocity region are discussed. The results obtained indicate the way energy is preferentially given to the perpendicular motion of the ion; an efficient energy transfer to the electrons, however requires a large electron velocity spread along the field lines. (France)

8748 (IPP–1/127, pp 25-8) HIGH-BETA REVERSED FIELD DISCHARGES WITH EXTENDED LIFETIMES. Gowers, C. W.; Nalesso, G. F.; Newton, A. A.; Robinson, D. C.; Verhage, A. J. L.; Bodin, H. A. B. (Culham Lab., Abingdon, Eng.). Jul 1972.

From 2nd topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Criteria for setting up stable reversed-field distributions are discussed, and experiments are described in which such configurations have been generated without instability or wall contact. The plasmas have $\beta_\theta \sim 0.8$ and lifetimes ~30 to 40 μsec, the classical resistive decay time of the confining magnetic fields. (auth)

8749 (IPP–1/127, pp 29-32) THEORETICAL AND EXPERIMENTAL STUDY OF HEATING AND ENERGY LOSSES IN PINCH DISCHARGES. Gowers, C. W. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Nalesso, G. E.; Newton, A. A.; Robinson, D. C.; Verhage, A.; Wootton, A.; Bodin, H. A. B. Jul 1972.

From 2nd topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

In HBTX z pinches, screw pinches and reversed-field pinches were investigated with probes, Thomson scattering, and spectrally resolved photography. The measured electron temperature and density distributions were compared with predictions from an MHD code using the full circuit. Agreement with experimental error is obtained in all cases for the compressed regions of the column starting with partially ionized initial conditions corresponding to the preionization plasma. For example, for stabilized pinches, both computation and experiment show that the temperature increases as I_z^2 with $\beta_\theta \sim 0.5$; the peak value obtained at 30 mtorr with a current of 90 kA is about 30 eV. Observed electron temperatures in the outer plasmas are lower than predicted, even when strong turbulent electron thermal conductivity is assumed in the computation. The effect of partial ionization in B_z compression heated systems was studied in positive and negative bias field in order to investigate ways of controlling beta. Experimentally and theoretically the rate of rise of temperature becomes sensitive to the degree of ionization when the electric field is reduced; in these conditions the heating rate is also very sensitive to the addition of small amounts of negative-bias field. (auth)

8750 (IPP–1/127, pp 103-6) INITIAL PHASE OF THETA PINCH WITH MULTIPOLE CUSP FIELD. Miyamoto, Tetsu (Nihon Univ., Tokyo); Nogi, Yasuyuki; Yoshimura, Hisamitsu; Hayase, Kiyoji. Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The theta-pinch experiment with the sixteen-pole cusp field (so-called Ioffe field), which could produce the nearly circular isobar in the vicinity of the discharge tube, was carried out. The plasma was strongly affected by the multipole cusp field at the initial phase of pinch. The main part of the plasma current was separated from the tube wall and was on the cylindrical surface with small ripples. The cusp losses existed and the plasma contacted with the tube wall through the line cusps. The trapped reverse field increased by the superimposing of the multipole cusp field at the start of the second half cycle. The results suggest that the multipole cusp field makes the preheating effective or that it permits the powerful preheating. For the rotating plasma the average radius and the ripples of the column were calculated. The cusp losses and the ripples of plasma column corresponding to the cusps vanished after the pinch. The instabilities were observed. It is, however, presumed that they do not directly relate with the multipole cusp field. (auth)

8751 (IPP–1/127, pp 107-10) ANALYSIS OF THE ENERGY BALANCE IN THE ISAR II LINEAR THETA PINCH BY EXPERIMENTAL AND COMPUTATIONAL INVESTIGATIONS. Engelhardt, W.; Koeppendoerfer, W.; Schneider, W.; Sommer, J. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Detailed energy balances were obtained for fast theta-pinch discharges by comparison of measured quantities with results of a two-dimensional (r,z) MHD code. Plasma heating, mass, and energy losses in regimes of isotropic and anisotropic plasma pressure were investigated. The distribution of energy losses into kinetic energy, convection, thermal conduction, and radiation losses is analyzed. The relation of this experiment to those of other groups is shown. (auth)

8752 (IPP–1/127, pp 119-22) SHOCK HEATING OF LOW-DENSITY PLASMAS IN A FAST THETA PINCH. Dietz, K. J.; Hoethker, K. (Kernforschungsanlage, Juelich, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Parameter studies are made during the implosion phase of a 120-kV theta pinch operated at low densities. Ion energies, compression ratios, and the width of the current sheath are measured in dependence on the initial density and the coil voltage. The measured values agree quite well with those obtained from the "free-particle" model. An anomalously broad current sheath is observed. Turbulent conductivity is derived from magnetic-field diffusion rates. (auth)

8753 (IPP–1/127, pp 127-30) SHEATH FORMATION AND ION HEATING IN LOW-DENSITY HIGH-VOLTAGE THETA PINCHES. Keilhacker, M.; Kornherr, M.; Lindenberger, F.;

Maret, G.; Niedermeyer, H.; Steuer, K.-H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Fast magnetic compression of a low-density (3×10^{10} to 3×10^{12} cm^{-3}) magnetic-field-free deuterium plasma in a 43-cm-diameter 500-kV theta pinch is investigated. In the whole range of densities, effective piston heating is observed, resulting in ion energies of a few 10 keV. For an initial deuteron density of 2.5×10^{12} cm^{-3} the sheath thickness during implosion is 8 c/ω_{peo} or 3 c/ω_{ce}. At maximum compression the mean ion energy is 15 to 20 keV, the deuteron density 4×10^{13} cm^{-3}, and the plasma radius 6 cm. From a model of anomalous-sheath broadening a scaling law for the low-density limit of shock compression is derived. (auth)

8754 (IPP–1/127, pp 139-41) TWO-STAGE HEATING OF THETA PINCHES. Freidberg, J. P.; Morse, R. L. (Los Alamos Scientific Lab., N. Mex.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The heating of θ pinches by fast implosion, followed by slow adiabatic compression, is discussed. Numerical simulations of the initial fast implosion are shown that indicate the technological requirements for this stage of the heating, and a scheme is shown by which the efficiency of this stage can be improved. From estimates of the effects of the thermalization on the subsequent slow compression, the fractional filling of the pinch tube can then be estimated. (auth)

8755 (IPP–1/127, pp 195-8) PLASMA CONFINEMENT IN THE TOROIDAL BELT PINCH. Krause, H.; Wilhelm, R.; Zwicker, H.; Grossmann, W. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Optical- and magnetic-probe measurements on the belt pinch, ISAR IV, are presented. They indicate a grossly stable confinement for about 100 μsec at temperatures of several tens of eV at $N_e = 10^{15}$ to 10^{16} cm^{-3}. Lifetime of the plasma is obviously limited by diffusion. (auth)

8756 (IPP–1/127, pp 213-16) THETA-PINCH PLASMA CONFINED IN A CAULKED-CUSP TORUS FIELD. Uchida, Taijiro; Sato, Koichi; Akiyama, Riuichi; Noda, Nobuaki; Inoue, Nobuyuki (Nagoya Univ., Japan). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A toroidal theta-pinch plasma is stably confined in a periodic caulked-cusp torus (abbreviated to C.C.T.) field which is formed by superposition of the field generated with the current induced inside the buried rings on the theta-pinch field. The toroidal drift of a theta-pinch plasma is suppressed and no macroscopical instabilities are observed. A relatively rapid decrease of the plasma pressure seems to be unavoidable, because it may result from the expansion of the cylindrical plasma pinched near the minor axis into the confining region of the C.C.T. field. The particle confinement may be limited by the plasma contacting on the inside of the ring, owing to the approach of the stagnation point. The approach is caused by the differences between the decay time of the coil current and that of the induced ring current, which originates in a proximity effect between both currents. (auth)

8757 (IPP–1/127, pp 217-20) PRELIMINARY STUDY OF HIGH-PRESSURE CONFINEMENT OF A Z PINCH: THEORY AND SOME EXPERIMENTAL RESULTS. Cheng, D. Y. (Univ. of Santa Clara, CA). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The high-temperature plasma in an arc channel surrounded by a much higher-density, low-temperature plasma, or neutral gas can be heated preferentially to even higher temperatures. This is because the electric conductivity increases with temperature as $T^{3/2}$ and the ohmic heating rate is proportional to the conductivity. Ordinarily, the heat losses from bremsstrahlung radiation and heat conduction is as $T^{1/2}$ only. However, the shrinking of the heated area will be slowed down by the cyclotron radiation as it loses heat as T^2. Experimentally, such an arc channel can be created by the explosion of a deuterium-filled metal tube; as a result, pure deuterium plasmas can be produced that are surrounded and confined by a high-density mass. Neutron signals will be presented, together with the current trace, to indicate the time of neutron production. Plasma density in the channel is estimated to be $7 \times 10^{17}/cm^3$ and $n\tau$ is about 6×10^{12} sec/cm^3. (auth)

8758 (IPP–1/127, pp 241-4) CO_2 LASER HEATING OF A SMALL THETA PINCH. Amherd, N. A.; Vlases, G. C. (Univ. of Washington, Seattle). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A small experiment involving a θ pinch 19 cm × 3.5 cm, irradiated axially by a 3- to 5-joule TEA laser, was used to study refraction and absorption. The results indicate that the beam is trapped and absorbed during periods in which the density profile is favorable. (auth)

8759 (IPP–1/127, pp 249-52) INTERACTION OF INTENSE RELATIVISTIC ELECTRON BEAMS WITH LINEAR PINCHES. Benford, James; Ecker, Bruce; Putnam, Sidney (Physics International Co., San Leandro, CA). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Intense relativistic electron beams (0.5 to 1 MeV, 100 to 400 kA) propagate in linear pinches with high efficiency. The beam–pinch interaction can be modeled as a single-particle orbit motion of beam electrons in the pinch field unless beam transverse pressure is comparable to unbalanced pinch pressure and $\beta \equiv [(nkT)_p + nW_{\perp b}]/B_\theta^2/8\pi > 1$, where $(nW_\perp)_b$ is the beam transverse energy density. A model of pinch field distortion due to transverse pressure imbalance is presented and applied to experimental data, and the results of a tapered pinch experiment to generate a local increase in β are described. Implications of the models to turbulent beam heating of pinch plasmas are briefly discussed. (auth)

8760 ION CONFINEMENT IN THE PRESENCE OF AN ELECTROSTATIC POTENTIAL AND r.f. ELECTRON PLUGS IN A MIRROR TRAP. Werkoff, F. (CEN, Fontenay-aux-Roses, France). Plasma Phys.; 14: No. 10, 897-904(Oct 1972).

Results of numerical calculations of the distribution functions of ions and electrons in the case of a hot-electron mirror trap are presented, using a new code solving two time-dependent Fokker–Planck equations. The plasma potential ensuring charge neutrality is calculated. The effect of this potential is to improve the trapping of the ions. The possible reduction of end losses by rf fields near the electron cyclotron frequency is also studied. (auth)

8761 DISSIPATION PICTURE OF NEOCLASSICAL DIFFUSION. Bickerton, R. J. (Culham Lab., Abingdon, Eng.). Nucl. Fusion; 12: No. 5, 609-11(Sep 1972).

A nonrigorous discussion is given of the dissipation mechanism responsible for plasma diffusion in the banana regime. It is shown that magnetic pumping of the electrons is responsible. (M.O.W.)

8762 TURBULENT HEATING OF PLASMA BY ULTRASHORT PULSES OF LASER RADIATION. Fanchenko, S. D.; Sholin, G. V. Dokl. Akad. Nauk SSSR; 204: No. 5, 1090-3 (11 Jun 1972). (In Russian).

The possible mechanisms of the turbulent heating of dense plasma in laser experiments are examined theoretically. The results of coarse evaluations were found to be in qualitative agreement with experimental data on plasma heating in which the plasma was considerably less dense. (K.S.W.)

8763 COMBINED HEATING OF A PLASMA BY AN ELECTRON BEAM AND INTENSE ION–CYCLOTRON WAVE. Bakai, A. S.; Ermakov, A. I.; Krivulya, S. S.; Nazarov, N. I.; Tolok, V. T. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1235-9(Oct 1972). (In Russian).

Results are presented of an experimental investigation of the interaction between an electron beam and plasma in which large-amplitude ion-cyclotron oscillations are excited by external high-frequency currents. It is shown that electromagnetic radiation in the uhf range arises which has a power of ~20 db greater than that of the uhf radiation from the usual beam–plasma interaction at the same plasma density. The uhf radiation frequency is the same as the electron plasma frequency. The amplitude of the radiation depends in a resonant manner on the strength of the external magnetic field and its maximum coincides with that of the ion cyclotron wave amplitude. The polarization of the uhf radiation observed corresponds to that of the extraordinary wave ($E \perp H_0$). The uhf radiation is amplitude-modulated at a frequency of the ion cyclotron wave. When the frequency of the uhf radiation is the same as the harmonics of the electron cyclotron frequency, the amplitude of the uhf radiation sharply drops and the gas-kinetic pressure of the plasma increases by 50 to 70%. (auth)

8764 INTENSE ELECTRON BEAMS: A FUSION MATCH. Benford, James; Benford, Gregory (Physics International Co., San Leandro, CA). New Sci.; 56: No. 822, 514-16(30 Nov 1972).

With the problems of confining a thermonuclear plasma looking less insuperable, fusion scientists are now tackling some of the other obstacles that stand between them and a commercial fusion reactor. One problem is how to heat up a plasma to a high-enough temperature. (auth)

Diagnostics

Refer also to abstract 8807.

8765 (AD-745166) EXPERIMENTAL AND ANALYTICAL STUDIES OF COLLISION-FREE PLASMA FLOWS. Final Report, April 1, 1966-June 30, 1971. Lees, L. (California Inst. of Tech., Pasadena). 30 Dec 1971. Contract F19628-70-C-0152. 15p. (AFCRL-72-74). NTIS.

Collision-free plasma flow phenomena were investigated experimentally and analytically. An experiment on the effect of the charge-exchange collisions between streaming ions and background neutral atoms and measurements of wakes behind simple bodies were conducted in a low-density plasma beam facility under carefully controlled laboratory conditions, in close coordination with theoretical analysis. (auth) (GRA)

8766 (AEC-tr-7367) DETERMINATION OF PLASMA DENSITY IN STELLARATORS BY MEANS OF AN OPEN MICROWAVE RESONATOR. Akulina, D. K.; Nechayev, Yu. I.; Sud'yenkov, V. Ya.; Fedyanin, O. I. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated from report NP-19284. 6p. Dep. NTIS.

Measuring resonators with high Q must be used in the measurement of plasma density in a wide range. Fabry-Perot-type open microwave resonators possess the required characteristics, but their use in stellarators encounters difficulties associated with resonator placement within the chamber without constricting its aperture. This and similar problems were satisfactorily solved for the measurement of plasma densities, and also for the measurement of resonance frequency shift. The apparatus for these measurements is diagrammed and discussed. (K.S.W.)

8767 (AEC-tr-7375) SPECTROSCOPIC EXAMINATION OF THE PARAMETERS OF A TURBULENT PLASMA. Berezin, A. B.; Dubovoi, L. V.; Lyublin, B. V.; Yakovlev, D. G. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). Translation of report NP-19262. 12p. Dep. NTIS.

A study was made of the parameters of a plasma in a highly turbulent state. Two branches of the oscillations in the discharge are isolated. The basic characteristics of these oscillations are estimated by the shape of the H_β hydrogen spectral line profile. In this experiment the intensity of the E fields of the turbulent pulsations was ≃6 kg/cm. The turbulent level $\epsilon = E^2/8\pi nT \approx 10^{-4}$. The degree of anisotropy of the oscillations was $E_{||}/E_{\perp} \simeq 3$. (auth)

8768 (EUR-CEA-FC-658) ELECTRON DENSITY MEASUREMENT IN THE CIRCE EXPERIMENT. Bardet, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1972. 23p. (In French). Dep. NTIS (U. S. Sales Only).

Three experimental devices used to measure the electron density at three different points in the CIRCE facility are described. The electron density is measured at the plasma source, before injection into the magnetic bottle, and in the magnetic bottle. (France)

8769 (IPP-1/127, pp 147-50) NEUTRON MEASUREMENTS, THOMSON SCATTERING, AND HOLOGRAPHIC INTERFEROMETRY ON THE FOCUS EXPERIMENT. Bernard, A.; Coudeville, A.; Durantet, J.; Jolas, A.; Launspach, J.; de Mascureau, J.; Watteau, J. P. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

When the Focus machine is operated at high-enough filling pressures the neutron fluences are equal in three directions and the energy spectrum on the axis is centered at 2.5 MeV ± 0.10. Measurements of the deuteron temperature and of the electron density are accomplished by Thomson scattering and holographic interferometry. (auth)

8770 (IPP-1/127, pp 205-8) NONCYLINDRICAL Z-PINCH DENSITY PROFILES FROM HOLOGRAPHIC INTERFEROMETRY. Bernard, A.; Jolas, A.; Launspach, J.; Watteau, J. P. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The plasma is created in a noncylindrical glass vessel with poor optical quality. Nevertheless, the density could be measured as a function of space and time by double-exposure holographic interferometry. Results are compared with numerical codes. (auth)

8771 (NP-19608) SIMPLE MODEL FOR ESTIMATION OF THE ELECTRON AND ION TEMPERATURE IN TURBULENT Z-DISCHARGES. Dubovoi, L. V.; Komin, A. V.; Fedyakov, V. P. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1972. 10p. (In Russian). Dep. NTIS.

The efficiency of ion heating in turbulent z discharges with anomalous resistance resulting from the excitation of ion-sound instability was investigated. Relations for calculation of the ion temperature at the maximum current of pulse discharges were obtained with regard to turbulent characteristics of the plasma. Calculation results of the ion temperature are in satisfactory agreement with data obtained in experiments on the plasma turbulent heating. (auth)

8772 ENERGY AND MASS ANALYSIS OF NEUTRAL PARTICLES EMITTED FROM A TOROIDAL THETA-PINCH PLASMA. Noda, N.; Sato, K.; Akiyama, R.; Inoue, N.; Uchida, T. (Nagoya Univ., Japan). Nucl. Fusion; 12: No. 5, 607-9(Sep 1972).

The measurement of neutral particles emitted from a toroidal theta-pinch device named Caulked Cusp Torus is described. This neutral-particle measurement can be used to determine the ion temperature of hydrogen plasma. Furthermore, the nature of the ions present in the plasma can be inferred from the mass spectrum of the emitted particles obtained by using a magnetic-momentum analyzer. Oscillograms of neutral flux from the discharge are described. (M.O.W.)

8773 NEW TECHNIQUE FOR MEASURING THE RADIAL TEMPERATURE DISTRIBUTION IN INHOMOGENEOUS AND INSTATIONARY PLASMA COLUMNS WITH CONSIDERABLE SELF-ABSORPTION. Meiners, D.; Weber, W. (Technische Univ., Hanover). Z. Naturforsch.; 27a: No. 11, 1601-6(Nov 1972). (In German).

The complete lateral distributions of emitted intensity and optical thickness of the instationary plasma column are measured simultaneously by probing the plasma with its own radiation and recording both distributions on a single high-speed spectrum. From these lateral distributions the radial distributions of the coefficients of emission and absorption are calculated and by application of Kirchhoff's law the radial temperature distribution is determined. This new technique was applied to an exploding wire plasma with 37,000 K on the axis. The mean deviations of three temperature distributions obtained by independent measurements at different wavelengths are less than 3 per cent. (auth)

Kinetics (General)

Refer also to abstract 8098.

8774 (AEC-tr-7369) THEORETICAL AND EXPERIMENTAL STUDIES OF DIRECT HIGH-CURRENT DISCHARGES IN A VACUUM. Aleksandrov, A. F.; Zosimov, V. V.; Rukhadze, A. A.; Savoskin, V. I.; Timofeev, I. B. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated from report NP-18972. 43p. Dep. NTIS.

High-current discharges can be used as powerful sources of radiation for "pumping" lasers (optical quantum generators). Hence, a more careful look at theory and experiment is justified. These discharges can be divided into two classes: (1) vacuum discharges, and (2) high-current discharge in a gaseous medium such as is caused by passing a high current through a thin metal wire. The theory is developed for the equilibrium distribution of density, velocity, magnetic field and temperature in transparent, nontransparent, and "gray" discharges. Confirmation of the theoretical conclusions was sought and found by taking spectral measurements on plasmas formed by exploding silver wires electrically in quartz vessels. Good agreement between theory and experiment was found. (TTT)

8775 (EUR-CEA-FC-635(Pt.1)) REPORT OF THE FONTENAY-AUX-ROSES RESEARCH GROUP, FEBRUARY 1 TO DECEMBER 31, 1971. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 194p. (In French). Dep. NTIS (U. S. Sales Only).

The Ionized Gas Section has orientated its research towards studies of closed tokamak-type configurations in the framework of projects aimed at establishing the conditions required to sustain thermonuclear reactions. The Plasma Physics Section reports the following from its fundamental physics research program: waves, microinstabilities, nonlinear effects, atomic physics, and applications to fusion problems (heating and diagnostics for TFR). The work of the Plasma Confinement Service involved experiments on open configurations: Deca and Bille en Tete (classical losses, evolution of the plasma distribution function, electron cyclotron radiation), the Stator II experiment (toroidal confinement with a central conductor), and the tokamak program (construction of the TFR machine, heating, and collisions in the plasma). (France)

8776 (EUR-CEA-FC-635(Pt.2)) REPORT OF THE GRENOBLE RESEARCH GROUP, FEBRUARY 1 TO DECEMBER 31, 1971. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 91p. (In French). Dep. NTIS (U. S. Sales Only).

An outline of the work accomplished by the General Ion Service in 1971 is given. The theoretical studies involved hf heating in

tori and straight configurations with hot electrons, microinstabilities and other wave plasma interactions, and the structure of the magnetic field in toroidal machines. The straight configuration machines are described. Experiments on instabilities, torus heating, optical diagnostics, microwave frequency, and low temperatures are reviewed. (France)

8777 (IPP-1/127, pp 187-90) CHARACTERISTIC PROPERTIES OF A PLASMA FLOW IN A PULSED MAGNETIC COMPRESSOR. Aretov, G. N.; Burdonskii, I. N.; Valkov, Yu. A.; Vasil'ev, V. I.; Lototskii, A. P.; Skvortsov, Yu. V.; Solovova, V. G.; Suslov, Yu. F. (Inst. of Atomic Energy, Moscow). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The results obtained from the studies of a hydrogen plasma accelerated in the plasma focus device are presented. It is shown that, as a current sheet moves in the interelectrode gap, the current loops are formed. The magnetic field energy of the loops is transferred to the plasma flow. The maximum plasma density in the focus was as much as $5 \times 10^{18}/cm^{-3}$. The efficiency of the device is calculated. (auth)

8778 (IPP-1/127, pp 257-60) PROPERTIES OF A COAXIAL DEFLAGRATION PLASMA GUN. Cheng, D. Y.; Wang, Peter (Univ. of Santa Clara, CA). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Deflagration discharge as a means of accelerating the plasma up to a velocity of 10^8 cm/sec is demonstrated by a coaxial plasma gun designed according to that principle. The difference between deflagration and detonation (snowplough) discharge is illustrated, through the magnetic field structure inside the gun barrel. Experimentally, the transition from deflagration to detonation discharges was found. The temperature and the density of the plasma streams were measured. The unique focusing capability of the deflagration discharge is demonstrated. Pendulum measurements for plasma impulses were made in a vacuum chamber. (auth)

8779 (UCRL-Trans-10653) GENERATION OF PULSED HIGH MAGNETIC FIELDS USING CAPACITIVE AND INDUCTIVE STORAGE SYSTEMS OR BY COMPRESSION METHODS. Schneider, D.; Salge, J. Translated for Univ. of California Lawrence Livermore Lab., Livermore from Z. Angew. Phys.; 31: No. 5-6, 346-59(1971). 35p. Dep. NTIS.

At present, high magnetic fields (250 kOe to 25 MOe) can only be generated for short duration (10^{-6} s to 10^{-1} s). Various shapes of magnetic fields can be realized by different energy-storage systems and coils. The magnetic field strength is limited by the available stored energy and the ability of the coil to withstand destruction due to mechanical stress, thermal heating, skin effect, magnetic shock waves, and electrical breakdown. High magnetic fields can be achieved also by magnetic-flux-compression techniques. Destroying effects, basic types of electrical generating circuits, coils, flux concentrators, flux compression generators, and the present state of high-magnetic-pulse-field generation are discussed. (auth)

8780 BEAM-PLASMA INTERACTION IN A LIMITED GEOMETRY: TEMPERATURE EFFECTS. Bouchoule, A.; Weinfeld, M. (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 275: No. 9, 303-6(28 Aug 1972). (In French).

The spatial evolution of a plasma-electron beam medium with a convective-type Cherenkov instability leads to an increase in the energy dispersion of the beam electrons. In order to investigate this phenomenon, a quantitative knowledge of the effects of temperature on the instability is required (growth, rate, phase velocity). This analysis is presented together with some results. (France)

8781 VARIATION OF A SEMI-MAXWELLIAN DISTRIBUTION OF ELECTRONS IN AN ACCELERATING ELECTRIC FIELD. Specht, H. v. (Medizinische Akademie, Magdeburg, Ger.); Winkler, R. Beitr. Plasmaphys.; 12: No. 3, 185-91 (1972). (In German).

Based on the collision-free Boltzmann equation, a computation is conducted of changes concerning the semi-Maxwellian distribution in accelerating electric fields. Aside from separation of the velocity distribution function in the isotropic and anisotropic portions, a quantitative comparison of the isotropic and anisotropic parts is performed for the distribution function in the accelerating electric field. Results obtained for the isotropic portion agree with the relations derived by Medicus (J. Appl. Phys., 32: 2512 (1962)) with other methods. (tr-auth)

8782 ELECTRON NUMBER DENSITY AND TEMPERATURE IN MPD-ARC THRUSTER EXHAUSTS. Michels, C. J.; Rose, J. R.; Sigman, D. R. (Lewis Research Center, Cleveland). AIAA (Amer. Inst. Aeronaut, Astronaut.) J.; 10: No. 11, 1395-6 (Nov 1972).

The electron number density and electron temperature of the exhaust of a pulsed, megawatt, MPD-Arc thruster are measured at a station located 30 cm downstream of the thruster throat. The measurements are taken every 10 to 20 μsec for a period of approximately 100 μsec after the plasma exhaust arrives at the measuring station. Measurements are made for various sets of thruster parameters. The mean deviation of the data scatter is presented to show the nature of the exhaust variation. The data are compared with earlier work at a measuring station closer to the thruster so as to define the nature of the exhaust expansion with and without a thruster auxiliary magnetic field. (auth)

8783 PLASMA EFFECTS IN STIMULATED COMPTON INTERACTION BETWEEN MATTER AND RADIATION. Galeev, A. A.; Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1266-82(Oct 1972). (In Russian).

Effects connected with stimulated Compton interaction between matter and radiation (plasma heating, distortion of the radiation spectrum, and induced light pressure) may occur at high plasma densities when the spectral radiation linewidth is smaller than the plasma frequency. The efficiency of the processes is calculated as a function of plasma density and temperature and angular aperture of the radiation beam. It is shown that the Kompaneets differential equation describing Compton interaction between matter and a spectrally broad isotropic radiation is valid in a low-frequency region down to the plasma frequency. The upper limit of the brightness temperature of the radiation from cosmic masers that is due to the line leaving resonance via induced Compton interaction with the plasma (in principle a similar analysis is appreciable to gasodynamic lasers) is found. (auth)

Kinetics (Experimental)

8784 (AEC-tr-7379) SPECTRA OF MAGNETIC PULSATIONS OF NONISOTHERMAL PLASMA. Livshits, M. A.; Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated from report NP-19291. 10p. Dep. NTIS.

Nonlinear interactions and the spectra of magnetic pulsations of isothermal, turbulent plasma have been previously investigated by these authors. Under conditions of nonisothermal plasma, ion-acoustic oscillations arise both at low frequencies (collision-free Alfven and MHD waves), and at high frequencies (spiral waves). The spectrum of the turbulence associated with the magnetic pulsations is the subject of a theoretical study in both of the indicated frequency regions. (K.S.W.)

8785 (EUR-CEA-FC-662) MEASUREMENT OF THE FAST NEUTRAL PARTICLES EMITTED BY THE PLASMA OF THE CIRCE EXPERIMENT. Bardet, R.; Dupas, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1972. 71p. (In French). Dep. NTIS (U. S. Sales Only).

The principal method of analyzing the energy of the neutral particles emitted by a plasma are reviewed together with the way in which the energy spectra of the plasma ions can be determined from the spectra of the neutral particles. The results of this study are subsequently used to determine the optimum geometrical dimensions of an energy analyzer system for the energies of the fast neutral particles emitted by the plasma in the CIRCE experiment. (France)

8786 (IPP-1/127, pp 135-8) ION THERMALIZATION IN STRONG, HIGH-BETA SHOCKS. Morse, D. L.; Destler, W. W.; Auer, P. L. (Cornell Univ., Ithaca, NY). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Strong, high-beta collisionless shocks are generated by the interaction of a flowing plasma with a magnetic obstacle in a plasma wind tunnel device. The shock waves thus formed are grossly stationary in the laboratory reference frame and simulate in many respects the Earth's bow shock. The upstream plasma flow is characterized by beta ≅3 and magnetosonic Mach number M ≅ 7, and the duration of the experiment is greater than one-half millisecond or 10 ion gyroperiods. The shock waves are observed to be nonstationary on a time scale comparable with the upstream ion gyroperiod. The electrons are heated only moderately, and the bulk of the upstream flow energy appears as thermal energy of the ions. Measurements of the ion energy distribution function as the shock wave is traversed are reported. The results are discussed in the context of current theories of particle thermalization in the bow shock. (auth)

8787 (IPP-1/127, pp 155-8) NATURE OF HIGHLY LOCALIZED X-RAY SOURCES IN THE PLASMA FOCUS. Bostick,

W. H.; Nardi, V.; Prior, W. J.; Rodriguez-Trelles, F. (Stevens Inst. of Tech., Hoboken, NJ). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

X-ray pinhole photos of spool-shaped x-ray sources in the plasma focus identify these sources with toroidal vortex structures with peak electron densities of $10^{20}/cm^3$ and peak magnetic fields of about 100 MG. A marked x-ray intensity anisotropy is observed. (auth)

8788 (IPP-1/127, pp 175-8) PROJECT OF A MEGAJOULE PLASMA FOCUS EXPERIMENT. Gourlan, C. (Laboratorio Gas Ionizzati, Frascati, Italy); Maisonnier, Ch.; Robouch, B.; Samuelli, M.; Benuzzi, A.; Fasoli, P. Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The scaling laws of the plasma focus devices of the Filippov type are established theoretically and shown to compare satisfactorily with the available experimental scaling laws. The main parameters of the megajoule experiment to be built in Frascati within the framework of a joint European program are deduced. Two-dimensional MHD numerical calculations confirm the theoretical expectations. (auth)

8789 (IPP-1/127, pp 179-82) MEASUREMENT OF BETA IN A PLASMA FOCUS. Morgan, P. D.; Peacock, N. J. (Culham Lab., Abingdon, Eng.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The electron and ion line densities obtained by interferometry during the collapse, dense-pinch, and breakup stages of a plasma focus discharge are reported. Using these values, together with previously reported values of the average temperatures of the particles, the Bennett relation, $I^2 \beta_\theta = 2 k \Sigma_{e,i} N\bar{T}$, is satisfied in the dense pinch for a value of β_θ(beta) ~ 0.6. This is consistent with a fluid model in which plasma is transiently in equilibrium with the self-magnetic field of the current in the pinch. (auth)

8790 (IPP-1/127, pp 183-6) FILAMENTS IN A 1-kJ PLASMA-FOCUS EXPERIMENT. Braun, K.; Fischer, Heinz; Michel, L. (Technische Hochschule, Darmstadt, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

This study deals with the influence of spoke-type filaments upon the formation and field structure of the focus in a 1-kJ experiment. Filaments may originate from the early stages of the breakdown that occurs across the insulator between the inner and outer electrode of the coaxial electrode arrangement. (auth)

8791 (IPP-1/127, pp 191-4) INVESTIGATION OF HIGH-ENERGY DEUTERONS IN THE PLASMA FOCUS DEVICE. Belyaeva, I. F.; Filippov, N. V. Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The energy spectrum and spatial distribution of high-energy deuterons in the plasma focus device with $\beta \sim 1$ are presented. The contribution of the deuterons with the energies $E_d \geq 300$ keV to the neutron yield does exceed 1%. (auth)

8792 MEASUREMENT OF IONIZATION RELAXATION TIMES IN SHOCK-HEATED KRYPTON AND XENON. Carls, H. (Univ., Kiel). Z. Naturforsch.; 27a: No. 11, 1597-1601(Nov 1972). (In German).

Total ionization-relaxation times were measured in shocked noble gases (Kr, Xe) by means of interferometric, schlieren, and spectroscopic methods. For xenon, there is good agreement with relaxation times measured by other authors. For krypton, experimental data have not been found in the literature. Discrepancies with calculated relaxation times are discussed. (auth)

Kinetics (Theoretical)

8793 (AD-745369) THEORETICAL STUDIES OF INTENSE RELATIVISTIC ELECTRON BEAM-PLASMA INTERACTIONS. Final Report. Putnam, S. (Physics International Co., San Leandro, Calif.). Jul 1972. Contract DASA01-68-C-0096. 390p. (PIFR-72-105; DNA-2849-F). NTIS.

A comprehensive survey of intense relativistic electron beam physics is presented, including detailed discussions of selected topics. The beam-generated plasma is characterized through charge production rules for calculation of gas breakdown times, conductivity at breakdown, and current neutralization. Longitudinal electrostatic instability theory is reviewed in the context of typical beam-plasma parameters and a model explaining the low-pressure transverse instability (the frozen hose) is given. Transport phenomenology without external fields and with external linear pinch and solenoidal fields is discussed and models are developed to define efficient beam transport conditions. (auth) (GRA)

8794 (COO-2059-15) NEGATIVE TEMPERATURE STATES FOR THE TWO-DIMENSIONAL GUIDING-CENTRE PLASMA. Joyce, Glenn; Montgomery, David (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). 1972. Contract AT(11-1)-2059. 44p. Dep. NTIS.

Theoretical development and numerical simulation are presented for the two-dimensional electrostatic guiding center plasma with positive total interaction energy. This is a system for which equilibrium statistical mechanics predicts that no spatially homogeneous thermal equilibrium state will exist. The nonexistence of the homogeneous thermal equilibrium state is associated with the phenomenon of "negative temperatures." Quasi-stable spatially inhomogeneous states are shown to form, and are characterized by macroscopic spatially-separated vortex structures. (auth)

8795 (IPP-1/127, pp 61-4) SPECTRUM OF IDEAL MHD. Tataronis, J.; Grossmann, W. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The spectrum of eigenmodes of the linearized equations of motion of ideal MHD is discussed. By ideal one means that the resistivity and viscosity of the fluid are zero, and that the pressure is a scalar. The eigenvalue problem to be considered can be written in the familiar form, $-\rho \omega^2 \underline{y} = \underline{F}(\underline{y})$, plus B. C. where the frequency ω arises from the assumption that the perturbed variables have a time dependence of $e^{i\omega t}$, $\rho(\underline{r})$ is the equilibrium mass density of the fluid, $\underline{y}(\underline{r},\omega)$ is the perturbation of the fluid velocity and $\underline{F}$ is a complicated differential operator representing the force acting on a differential fluid element and is dependent only on the position vector $\underline{r}$. (M.O.W.)

8796 (IPP-1/127, pp 99-102) NEGATIVE THETA PINCH. Kawakami, Ichiro; Sato, Koichi; Akiyama, Riuichi; Uchida, Taijiro (Nagoya Univ., Japan). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Numerical computations on a negative theta-pinch process are carried out. An artificial resistivity often serves to suppress the onset of some numerical instabilities in the computation, and is chosen relating to the anomalous resistivities, which are studied theoretically. Several types of artificial resistivity are examined in the computation and it is found that one which is one-hundredth of the Sagdeev resistivity seems to be most plausible, even in the case of the negative theta pinch. Using this resistivity, numerical calculations are made on both negative and ordinary theta-pinch processes. Compared with the ordinary pinch, the negative theta pinch builds a higher-temperature region near the wall and a lower one near the center of the plasma column at the maximum contractio... Stored energy per unit length in the negative theta-pinch plasma is comparable with that of the ordinary pinch plasma. (auth)

8797 (IPP-1/127, pp 151-4) CRITICAL COMPARISON OF A TWO-DIMENSIONAL MHD CODE AND A FOCUS EXPERIMENT. Basque, G.; Patou, C.; Vezin, R. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The Potter MHD code was adapted to the geometry of the first focus experiment to make a direct comparison between computational results and experimental measurements. First runs with a gross scale mesh (Lax-Wendroff double step ~ 0.3 cm) gave a dynamics a little slower than in the experiment, same maximum densities, but maximum temperatures (500 eV) much lower than the several keV estimated by the x-ray absorbing-foil technique. After correction of several transport coefficients one obtained an enhancement of the maximum temperature of less than 20%. To increase the precision of the computation, as a first step, the linear mesh size was divided by two (0.15 cm, 5 hours run). This middle scale mesh run gave a good dynamics and maximum temperatures of the order of one keV. Then the computation is much more sensitive to the choice of the transport coefficients and artificial viscosity. The experiment is a Mather-type one of 14.5-kJ energy (capacitance 90 μF, voltage 18 kV) with an initial pressure of 3-torr deuterium ($n_e = 2 \times 10^{17}$ cm^{-3}). (auth)

8798 (IPP-1/127, pp 159-62) THEORY OF THE VORTEX BREAKDOWN IN THE PLASMA FOCUS. Gratton, Fausto (Univ., Buenos Aires). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Disruption of vortices having axial plasma flow was observed in a plasma-focus device. A simple theoretical model is developed that gives the breakdown condition, the increase of the radius of the vortex, and the energy released. Several observed features of the plasma-focus vortices can thus be explained. (auth)

8799 (IPP-1/127, pp 163-6) TOROIDAL VORTICES IN PULSED PLASMA. Nardi, V. (Stevens Inst. of Tech., Hoboken, NJ). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A theory of plasma vortices with a toroidal configuration is derived by solving the equations for self-consistent fields and phase-space density f_i for ions and electrons. The f_i equations contain source terms which account for radiative and collision phenomena by the source method used in a previous theory of magnetic bundles in dense plasmas. (auth)

8800 (IPP-1/127, pp 171-4) MODEL FOR THE DENSE PLASMA FOCUS. Maisonnier, Ch.; Pecorella, F.; Rager, J. P.; Samuelli, M. (Laboratorio Gas Ionizzati, Frascati, Italy). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A model in which the plasma column is disrupted, after maximum compression (first neutron burst), by m = 0 instabilities, and later heated to higher temperatures (second neutron burst) by turbulent mechanisms, seems to check well with experimental observations. (auth)

8801 (LYCEN-7208) EQUATIONS DESCRIBING A QUASI-NEUTRAL HEAVY ION PLASMA CONFINED IN A MAGNETIC FIELD. APPLICATION TO ION SOURCES. Tauth, T. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 18p. (In French). Dep. NTIS (U. S. Sales Only).

Two methods based on the analysis of macroscopic phenomena are presented: a method describing the elementary processes occurring in an isolated plasma containing multicharged heavy ions, a second method using the MHD equations and electrodynamics to explain certain characteristics of the discharge column. The formalisms presented enable the connection between the structure of the plasma and the confining magnetic field to be appreciated. (France)

8802 MAGNETOHYDRODYNAMIC MODEL OF UNSTEADY ACCELERATION OF PLASMA. Samarskii, A. A.; Kurdyumov, S. P.; Kulikov, Yu. N.; (and others) (Inst. of Applied Mathematics, Moscow). Dokl. Akad. Nauk SSR; 206: No. 2, 307-10(11 Sep 1972). (In Russian).

Pulsed accelerations of plasma are encountered in an experimental investigation which may be interpreted in terms of existing simplified models. A model of an accelerator, which consisted of two plane-parallel ideally conducting electrodes of infinite length, is examined. Lagrange coordinates are employed to express one-dimensional nonsteady-state equations of radiation. Two variants are explored: an accelerator with a first half-period of discharge current of 20 μsec and 20-kA current; and a second variant which considered acceleration of a Li plasma, initial density = 1.5×10^{-5} g/cm^2 during a discharge with a half-period of 16 μsec and an amplitude of 34-kA current. (K.S.W.)

8803 THEORY AND NUMERICAL CALCULATION OF A TOROIDAL ELECTRIC ARC PLASMA ALLOWING FOR AN INDUCED FLOW. Wynands, A. Aachen; Technische Hochschule (1971). 113p. (In German).

Thesis.

Theoretical study of a plasma produced by a steady electric arc discharge in a tube of curved toroidal geometry is given. Particular attention is given to the nonuniform heat transfer through the tube wall, to the parabolic decrease of the electric field with the distance from the main point of toroidal wall curvature when a current passes toward the torus core, and to the double magneto-hydrodynamical vortex which develops in the cross section of the discharge tube and produces convective heat transfer. A model is derived to describe these processes. A system of four coupled quasi-linear elliptic differential equations is set up to describe the thermal flux potential, the magnetic field and the vortex function in this system. A relaxation procedure is applied to solve the equations in a discrete form. (IAA)

8804 THEORY OF PARAMETRIC INTERACTION BETWEEN A HIGH FREQUENCY FIELD AND MAGNETOACTIVE PLASMA. Andreev, N. E. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1283-92(Oct 1972). (In Russian).

Instability of a plasma located in stationary magnetic and uhf electric fields in considered with respect to excitation of non-potential electron oscillations parametrically coupled to low-frequency potential perturbations. The threshold value of the uhf field strength for development of such instability is determined, and expressions are obtained for the maximal increments in the case of weak- or strong-perturbation coupling. Nonresonance kinetic instability of a magnetoactive plasma due to the inverse Cherenkov effect for electrons is investigated. The theoretical results obtained are compared with available experimental data. (auth)

Production

Refer also to abstract 8221.

8805 (EUR-CEA-FC-652) OPERATIONAL PROPERTIES OF A HELICAL MICROWAVE SOURCE UNDER HIGH DENSITY PLASMA AND INTENSE MAGNETIC FIELD CONDITIONS. Cano, R.; Lisitano, G.; Zanfagna, B. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1972. 16p. (In French). Dep. NTIS (U. S. Sales Only).

The main features of a helical-type microwave plasma source are presented. The microwave power (1.5 kW at 2.45 GHz) is maintained constant. The vacuum system has a basic pressure of 10^{-6} torr: hydrogen and argon are used in the region 10^{-4} to 10^{-2} torr. The magnetic field intensity is varied in the $1 \leq F_{ce} / F \leq 30$ range. Plasma densities of between 10^{11} and 10^{13} cm^{-3} and electron temperatures of between 1 and 15 eV are obtained. The degree of ionization was estimated to vary between 1% and 30%. (France)

8806 (IPP-1/127, pp 245-8) FORMATION OF HIGH-β FUSION PLASMAS WITH INTENSE RELATIVISTIC ELECTRON BEAMS. Putnam, S. D.; Stallings, C. H. (Physics International Co., San Leandro, CA). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The availability of intense relativistic electron beams with a wide range of parameters (energies up to megajoules, power levels up to 10^{13} to 10^{14} watts) and the continuing downward trend in the cost of electron beam power systems make these beams interesting energy sources for generating high-β, high-temperature plasmas. Various beam-plasma energy-transfer mechanisms are considered in the context of existing beam parameters: (1) collisional, (2) excitation of turbulent fields, and (3) energy transfer via zero-order fields. (Zero-order fields refer to beam-induced space charge and B_θ fields and dia- or paramagnetic changes in an externally applied longitudinal field.) It is also shown that electron-beam-accelerated ions can be used as energy supplements for high-density plasmas as, e.g., the dense plasma focus. (auth)

8807 (UCRL-50021-72-1) LASER-FUSION PROGRAM SEMIANNUAL REPORT: JANUARY-JUNE 1972. Kachen, G. I. Jr.; Clements, W.; Genin, M. (eds.) (California Univ., Livermore. Lawrence Livermore Lab.). 12 Jul 1972. Contract W-7405-eng-48. 142p. Dep. NTIS.

Research on the following topics is discussed: (1) laser research and development, (2) laser-produced plasmas, (3) diagnostics, and (4) laser fusion. (M.O.W.)

8808 GASODYNAMIC STRUCTURE OF A PLASMA FLARE PRODUCED BY EVAPORATION OF METALS BY INTENSE OPTICAL RADIATION. Batanov, V. A.; Bunkin, F. V.; Prokhorov, A. M.; Fedorov, V. B. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1240-6(Oct 1972). (In Russian).

The gasodynamics of vapor produced during evaporation of metals under the action of millisecond intense optical radiation pulses is investigated theoretically and experimentally. Heating of the vapor near the target by the laser radiation is observed experimentally. The initial conditions for movement of the vapor are studied. The gas phase flow j_1 is calculated on basis of the measured gasodynamic parameters. The dependence of j_1 on intensity of the incident radiation indicates that the extreme temperature corresponding to the liquid metal-liquid dielectric transition is attained at the surface of the target. (auth)

Stability

8809 (EUR-CEA-FC-648) NUMERICAL STUDY OF PLASMA EQUILIBRIUM IN THE HARMONICA MACHINE. Ginot, P.; Plinate, P.; de Sacy, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Aug 1972. 50p. (In French). Dep. NTIS (U. S. Sales Only).

A theory developed by Mercier, Misguish, and Adam shows that singularities occur in the description of plasma equilibrium in toroidal geometry whenever the rotational transform is equal to

certain critical values linked to the curvature of the toroidal magnetic axis. In general, this curvature varies along the torus. The theory is applied to the guitar-shaped torus of the Harmonica machine constructed at Fontenay-aux-Roses. (France)

8810 (IPP-1/127, pp 37-40) OBSERVATIONS OF M.H.D. INSTABILITIES NEAR THE KRUSKAL-SHAFRANOV LIMIT IN LINEAR AND TOROIDAL HIGH-BETA PINCHES. Pasco, I. K.; Robinson, D. C.; Smeulders, P. P. L. A. (Culham Lab., Abingdon, Eng.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The growth rate and wavelength of MHD instabilities were measured in the High-Beta Toroidal Experiment and its linear 2-meter counterpart over a wide range of pitch lengths ($2\pi r B_z/B_\theta$). Optical and electrical measuring techniques are used. The wavelength of the Kruskal-Shafranov m = 1 instability varies in accordance with q[= $(r B_z/R B_\theta)$, toroidal, = $(\pi r/L) \cdot (B_z/B_\theta)$ linear]. The growth rate of the instability is found to be approximately proportional to the axial current in the straight system, and this agrees with theory for small plasma displacements. The m = 1 instability disappears in both cases at the Kruskal-Shafranov limiting value of $q(r_m) = 1$ where r_m is the radius at which q is a minimum. This lies near the plasma boundary in the linear case and further out in the torus. Values of q up to 3 were studied and in the toroidal experiment evidence of an m = 2 instability was obtained when $q \sim 2.5$. The field configuration was varied by altering the pre-ionization current induced in the plasma, and configurations were usually of the screw-pinch type, with the current flowing principally in the outer regions. In the linear device measurements below 12 kA were made with the current flowing principally in the plasma column. (auth)

8811 (IPP-1/127, pp 41-4) EXPERIMENTAL RESULTS ON THE HIGH-β COMPACT TORUS EXPERIMENT TEE. Belitz, H. J.; Kugler, E.; Noll, P.; Sand, F.; Waidmann, G.; Waelbroeck, F. (Kernforschungsanlage, Juelich, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A plasma is produced by fast rising magnetic fields in a Tokamak-like configuration to study its stability for the case $\beta_J > 1$ (poloidal β) and $q = (2\pi/\iota) \gtrsim 1$. With $B_{max} = 4{,}3$ kG and a filling pressure $p_o = 1$ mtorr D_2, an initial plasma with an aspect ratio $A_p \approx 5$, a major radius $R_p \approx 28$ cm, $\bar{\beta} \approx 0.1$, $\bar{T} \approx 150$ eV and $q(a) \approx 0.8$ was obtained. After crowbar, the plasma current I_p decreases in $\sim 10^{-4}$ sec and no major MHD instabilities were found when I_p is smaller than the Kruskal-Shafranov limit. (auth)

8812 (IPP-1/127, pp 45-8) VLASOV-FLUID MODEL FOR STUDYING GROSS STABILITY OF HIGH-BETA PLASMAS. Freidberg, J. P.; Lewis, H. R. (Los Alamos Scientific Lab., N. Mex.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A formulation of the Vlasov-fluid model in a way suitable for numerical computation is described, and application to equilibria with axial and translational symmetry discussed. (auth)

8813 (IPP-1/127, pp 49-52) EXPANSION OF TOROIDAL EQUILIBRIUM WITH FINITE PERIODICITY LENGTH AND $\hat{l}$ = 0,1 FIELDS IN LEADING ORDER. Herrnegger, F.; Nuehrenberg, J. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The existence of an expandable toroidal magneto-hydrostatic equilibrium with finite rotational transform, but without Pfirsch-Schlueter correction, is investigated. Under the specific scaling used, a solution accurate to second order (which includes the toroidal effects) exists only for a uniquely determined pressure profile. (auth)

8814 (IPP-1/127, pp 53-6) CLASS OF HELICALLY SYMMETRIC MHD EQUILIBRIA. Correa, D.; Lortz, D. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Helically symmetric equilibria are discussed for the case that the equation is linear. (auth)

8815 (IPP-1/127, pp 69-72) MHD STABILITY STUDIES OF NUMERICALLY OBTAINED TOROIDAL EQUILIBRIA. Baker, D. A.; Mann, L. W. (Los Alamos Scientific Lab., N. Mex.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

This work pertains to axisymmetric toroidal MHD equilibria and their stability. Of particular interest are high-β equilibria with hollow-pressure profiles as observed experimentally in the Los Alamos toroidal z pinch. This study includes toroidal-curvature effects in the determination of MHD stable toroidal z-pinch configurations. Diffuse profile toroidal equilibria, free from limitations on aspect ratio, were obtained numerically. These solutions are analyzed for MHD stability by means of a double Fourier expansion of δW in the poloidal and toroidal variables and finite differencing the remaining variable. The resulting large, quadratic form is then tested for positive definiteness corresponding to stability. (auth)

8816 (IPP-1/127, pp 73-6) STABILITY OF TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC EQUILIBRIA. Freidberg, J. P.; Marder, B. M. (Los Alamos Scientific Lab., N. Mex.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A numerical procedure is presented for computing the stability of high-β, diffuse two-dimensional magnetohydrodynamic equilibria. The method is tested on the problem of the bumpy θ pinch with arbitrary-size bumpiness. (auth)

8817 (IPP-1/127, pp 77-80) STABILITY OF A FINITE-β, l = 2 STELLARATOR. Freidberg, J. P. (Los Alamos Scientific Lab., N. Mex.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The stability of an infinitely long, high-β, l = 2 stellerator is investigated. The calculation is carried out by using the new Scyllac expansion in the sharp-boundary ideal magnetohydrodynamic model. It is found that for any given size l = 2 field and mode number m, an infinite but discrete set of wavenumbers k exist for which the plasma is unstable to all β; that is the critical β equals zero. These modes can be described as long-wavelength interchanges. Thus, with regard to sharp boundary stability, neither l = 0 nor l = 2 offers any particular advantage over the other as a sideband field required to produce toroidal equilibrium in the l = 1 Scyllac configuration. (auth)

8818 (IPP-1/127, pp 83-6) COMPUTATION OF GROWTH RATES OF INSTABILITIES FOR A GENERAL PINCH CONFIGURATION. Crow, J. E.; Robinson, D. C. (Culham Lab., Abingdon, Eng.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A comprehensive 1D computer code was written to calculate growth rates of instabilities in both experimental and theoretical situations, and their associated eigenfunctions. Completely general field and density profiles are used; both incompressible and compressible motions were considered, and a full treatment of the vacuum region between the plasma and the conducting wall is included. The results for growth rates, wavelengths, and eigenfunctions show good agreement with experiment. (auth)

8819 (IPP-1/127, pp 95-8) PROPAGATION OF m = 1 ALFVEN WAVES IN A HIGH-BETA PLASMA COLUMN. Wooton, A.; Nalesso, G. F.; Newton, A. A. (Culham Lab., Abingdon, Eng.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A small coil near a long theta-pinch plasma column is used to excite m = 1 gross motion. Displacements ~0.5 cm are observed that propagate along the column at 10 to 20 cm/μs. A model is presented for plasma motion about a displaced equilibrium prescribed by the total magnetic field. (auth)

8820 (IPP-1/127, pp 131-4) ELECTROSTATIC INSTABILITIES IN A COLLISIONLESS PLASMA DRIVEN BY AN ELECTRIC CURRENT PERPENDICULAR TO THE MAGNETIC FIELD. Lashmore-Davies, C. N.; Martin, T. J. (Culham Lab., Abingdon, Eng.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The growth rates γ and frequencies of fast-growing instabilities ($\gamma > \omega_{ci}$, where ω_{ci} is the ion cyclotron frequency) are computed for a wide range of parameters. The many instabilities that can occur are related to each other and compared in an attempt to decide under what conditions a given instability will dominate. (auth)

8821 (IPP-1/127, pp 143-6) ASYMPTOTIC BEHAVIOUR OF THE ELECTROSTATIC CURRENT-DRIVEN CROSS-FIELD INSTABILITY. Biskamp, D.; Chodura, R. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Onset, evolution, and final state of the instability driven by

a current perpendicular to a magnetic field are investigated in one- and two-dimensional computer-simulation experiments. Though the influence of the magnetic field is quite different in one- and two-dimensional plasmas, the final state is characterized by $U \sim c_s$ (U drift; c_s ion-acoustic velocity) where the instability switches off. Peak values of the effective collision frequency during the heating period are $\sim 5 \times 10^{-3}\ \omega_{Pe}$ independent of ion mass in two-dimensional calculations. (auth)

8822 (IPP–1/127, pp 199-200) BELT-PINCH EQUILIBRIA WITH SMOOTH CURRENT DISTRIBUTION. Herrnegger, F. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Exact toroidal MHD equilibria of the belt-pinch type with a toroidal current density proportional to the flux function are calculated. The solutions depend on a single parameter whose value is determined by the β value, the torus radius, and the half-axis ratio of the plasma cross section. The equilibria satisfy the necessary Mercier criterion for local stability in a certain parameter range. (auth)

8823 (IPP–1/127, pp 221-4) MHD STABILITY CONSIDERATIONS OF THE BELT PINCH. Grossmann, W. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

An infinitely long MHD approximation to the belt-pinch plasma is made and its stability is examined. Reversing m and k, the usual Fourier variables allow standard theoretical treatments, and a variety of possible unstable modes are found which, due to other considerations, are suppressed. (auth)

8824 (IPP–1/127, pp 233-6) DYNAMIC STABILIZATION EXPERIMENTS WITH STANDING-WAVE MAGNETIC FIELDS. Becker, G.; Gruber, O.; Herold, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The standing-wave magnetic field applied for dynamic stabilization of the helical m = 1 mode of a linear screw pinch does not affect the growth of this mode, although stability conditions of theory are fulfilled. Parametric excitation of other modes is not observed. (auth)

8825 ION ACOUSTIC INSTABILITY IN COLLISIONLESS SHOCKS. Priest, E. R.; Sanderson, J. J. (High Altitude Observatory, Boulder, CO). Plasma Phys.; 14: No. 10, 951-8 (Oct 1972).

The effect of temperature, density, and magnetic field gradients on ion acoustic instability in perpendicular collisionsless shocks is investigated. For typical experimental conditions, the temperature gradient increases the growth rate by as much as an order of magnitude, the other gradients having negligible effect. It is shown that this increase is due to a distortion of the steady-state electron distribution function. (auth)

8826 PERPENDICULAR COLLISIONLESS SHOCK WAVE INSTABILITY. Sanderson, J. J.; Priest, E. R. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Plasma Phys.; 14: No. 10, 959-66(Oct 1972).

An investigation into the effects of temperature, density, and magnetic field gradients on the linear instability of longitudinal waves in perpendicular collisionless shocks is reported. The dispersion relation for the propagation of Bernstein modes in an inhomogeneous plasma is derived and solved within defined limits. For warm ion shocks the temperature gradient can result in a significant increase in the growth rate. For typical experimental conditions, however, this increase is cancelled out by the stabilizing effect of the magnetic field gradient. The latter effect increases with wavenumber. (auth)

8827 INSTABILITY OF NONLINEAR LONGITUDINAL OSCILLATIONS OF MAGNETOACTIVE PLASMA. Demchenko, V. V.; El-Naggar, I. A. (Atomic Energy Commission, Cairo). Plasma Phys.; 14: No. 10, 967-70(Oct 1972).

The combined effect of including spatial dispersion and nonlinearity is shown to lead to the possible existence of steady nonlinear longitudinal monochromatic waves, whose frequency is close to the Langmuir plasma frequency. (auth)

8828 THERMAL STABILITY OF A SPATIALLY NONUNIFORM PLASMA IN A D–T FUSION REACTOR. Yamato, H.; Ohta, M.; Mori, S. (Japan Atomic Energy Research Inst., Tokai). Nucl. Fusion; 12: No. 5, 604-6(Sep 1972).

In the discussion, the diffusion coefficient and the thermal conductivity are considered to depend on temperature and density. As the dependence is not known in a reactor plasma at present, the following three types are used: $D = A_1F$, $K = A_2nF$, and

$$F = \begin{cases} 1 \\ T \\ n^2/T^{1/2} \end{cases}$$

where A_1 and A_2 are constant. These three cases are designated by const., Bohm, and classic, respectively. For simplicity, cylindrically symmetric distributions are assumed not only in the steady states but also in perturbed states. Diagrams showing the relationship between these cases are discussed. (M.O.W.)

8829 THERMODYNAMIC DESCRIPTION AND STABILITY CONDITION OF A NON-VISCOUS PLASMA IN STATIONARY MOTION. Lebon, G. (Univ., Louvain, Belg.); Casas-Vasquez, J. Ann. Soc. Sci. Brux. Ser. I; 86: No. 2, 227-40(1972).

It is shown that the stationary motion of a compressible and fully ionized plasma may be described by a variational principle expressing that the rate of entropy production is extremum when the generalized thermodynamic fluxes are kept constant. The problem of the stability of the motion is also examined. Using Liapunov's method, a sufficient condition for stability is given. (auth)

8830 EFFECTS OF HALL CURRENTS AND COLLISIONS WITH NEUTRALS ON THE DYNAMIC STABILITY OF A COMPOSITE HYDROMAGNETIC PLASMA. Bhatia, P. K. (Univ. of Jodhpur, India); Ariel, P. D. Nuovo Cim.; 12B: No. 1, 27-34 (11 Nov 1972).

The dynamic stability of a semi-infinite composite hydromagnetic plasma was investigated to include simultaneously the effects of Hall currents and the frictional effects with neutrals. The prevailing magnetic field is assumed to be uniform and horizontal. First it is shown that the solution is characterized by a variational principle. The explicit solution was then obtained for a plasma of variable density. The stratification in density was taken to be one-dimensional and in the direction of gravity. It is found that both the Hall currents and the frictional effects with neutrals have a destabilizing influence as part of the wave number range, which is stable in their absence, and rendered unstable by their presence. (auth)

8831 INSTABILITY OF A CURRENT-CARRYING PLASMA AT CYCLOTRON HARMONICS AND THE ANOMALOUS RESISTANCE. Lominadze, D. G. (Inst. of Physics, Tbilisi, USSR). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1300-11(Oct 1972). (In Russian).

A theory is developed of instability of a current-carrying plasma at electron-cyclotron frequencies; the nonlinear stage of the process is investigated. The magnitude of the anomalous resistance that appears as a result of cyclotron harmonic buildup is determined. In the given case, the appearance of the anomalous resistance itself (anomalous scattering of electrons by vibrations) leads to stabilization of the instability. The idea of the approach to nonlinear saturation of instabilities of the kind considered here is that use is made of the analogy between the role of ordinary binary collisions and of particle scattering by vibrations created in an unstable plasma. (auth)

8832 EXCITATION OF PARAMETRIC INSTABILITIES IN A MAGNETOACTIVE PLASMA BY AN U.H.F. PUMPING WAVE. Andreev, N. E.; Batanov, G. M.; Sarksyan, K. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1247-53(Oct 1972). (In Russian).

An investigation is made of the nonthermal radiation from a magnetoactive plasma interacting with an uhf pumping wave whose frequency, ω_0, exceeds the electron Langmuir frequency, ω_{Le}, but is less than the electron cyclotron frequency ω_{He}. Radiation is observed at a frequency which is shifted to lower frequencies by an amount which is of the order of the ion-sound oscillation frequency ω_s. The dependence of the radiation with a frequency equal to that of the second harmonic of the uhf pumping wave frequency, $2\omega_0$, on plasma concentration is obtained. The relation between the radiation observed and development of parametric instabilities is discussed. (auth)

8833 THEORY OF PARAMETRIC RESONANCE IN AN INHOMOGENEOUS PLASMA. Aliev, Yu. M.; Gradov, O. M.; Kirii, A. Yu. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1254-65(Oct 1972). (In Russian).

A kinetic theory is developed to the dispersive properties of longitudinal oscillations in a layer of an inhomogeneous plasma located in an external high-frequency electromagnetic field. The range of external field frequencies is studied in which the frequencies are close to the proper frequencies of the electron surface or volume Langmuir oscillations. The cases of transparent or opaque plasma layers are considered. Threshold values of the hf field strengths are found and the near-threshold increments are determined. It is shown that growth of ion-sound waves occurs throughout the plasma despite the fact that surface-electron

and localized Langmuir oscillations exist in small regions of the plasma layer. It is found that volume ion-sound oscillations may be excited in an opaque plasma if the plasma layer thickness considerably exceeds the size of the skin layer. The effect of inhomogeneity on parametric instability in a strong hf field is studied. (auth)

Thermonuclear Processes

8834 (IPP–1/127, pp 21-4) TOROIDAL HIGH-BETA STELLARATOR EXPERIMENTS ON ISAR T 1. Fuenfer, E.; Kaufmann, M.; Lotz, W.; Muenich, M.; Neuhauser, J.; Schramm, G.; Seidel, U. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Toroidal theta-pinch experiments on ISAR T 1 using different combinations of $l = 1$, $l = 2$, and partly $l = 0$ fields are described. Best results are obtained with a mixture of all field components. For better understanding of the dynamical phase, forces of the stellarator fields on a not-deformed plasma cylinder were calculated. (auth)

8835 (IPP–1/127, pp 57-9) SPECIFIC MAGNETIC INDUCTANCE FOR TOROIDAL SYSTEMS. Bateman, R. G. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The magnetic inductance matrix, which depends upon geometry alone, was generalized to toroidal systems with distributed current. This generalization can be made after the magnetic energy is minimized on each flux surface, holding the surface shapes and flux profiles fixed ($\rightarrow j \cdot \nabla\Psi = 0$). It then follows that the flux between differentially close surfaces equals the total current within the surface times the specific inductance (the matrix relates longitudinal and azimuthal components). A special coordinate system appears naturally in the derivation and provides a useful alternative to Hamada coordinates. The coordinate system depends upon geometry alone, but, in it, the magnetic field lines are straight. The general formalism can be applied to the approximation of flux surface shapes for plasma systems with a given topology. The specific inductance can be explicitly calculated for systems with an ignorable coordinate. (auth)

8836 (IPP–1/127, pp 87-90) PADOVA HIGH-BETA PROGRAM. Malesani, G. (Univ., Padua). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The program deals with the early stages of toroidal pinches. An account is given of the considered problems and of preliminary works on ionization, heating, and diffusion. A new 120-kJ flexible toroidal Z–Θ device is described. (auth)

8837 (IPP–1/127, pp 115-18) MODELING OF LONG STRAIGHT THETA PINCHES. Gula, W. P.; Morse, R. L. (Los Alamos Scientific Lab., N. Mex.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Theoretical models of straight θ pinches, including a two-dimensional (r & Z) transport code, were constructed. Ions and electrons are treated separately and electron thermal conduction is included. Preliminary results agree well with previous θ-pinch experiments. The results of these models are compared with recent experimental measurements on the five-meter Los Alamos θ pinch. (auth)

8838 (IPP–1/127, pp 123-6) PROPERTIES OF A LARGE-DIAMETER, FAST THETA PINCH OPERATED AT LOW DENSITIES. Dietz, K. J.; Dippel, K. H.; Hintz, E. (Kernforschungsanlage, Juelich, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Studies of the dynamic phase of a high-voltage theta pinch as reported earlier are extended to times where pressure equilibrium exists. Mean ion energies derived from the neutron yield and from the pressure-balance equation are compared. The width of the current sheath and the plasma β are obtained from radial magnetic field profiles as a function of the line density. There is no indication that the insertion of probes changes the plasma properties. Observations show also that the plasma is rapidly lost near current maximum. First results on the influence of magnetic-bias fields on plasma properties are presented. (auth)

8839 (IPP–1/127, pp 167-70) THEORY OF THE ADIABATIC CONTRACTION OF THE Z PINCH. Gratreau, P. (Laboratorio Gas Ionizzati, Frascati, Italy). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The theory of the collisionless "z-pinch" equilibrium is developed in the hypothesis of a radial adiabatic contraction. A detailed solution is established in the particular case of no ambipolar field, where an axial electron beam is supposed to generate the radial electrostatic field. As in the Bennett static equilibrium, there is no radial variation of temperatures; the density, the magnetic field and the macroscopic axial velocities are increasing towards the axis. In a numerical example, the drift velocities are shown to be of the order of the macroscopic ones. (auth)

8840 (IPP–1/127, pp 201-4) INFLUENCE OF THE EXTERNAL CIRCUIT ON THE DECAY OF THE INDUCED PLASMA CURRENT. Oomens, A. A. M.; Meddens, B. J. H. (FOM-Instituut voor Plasmafysica, Jutphaas, Netherlands). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

In pulsed toroidal devices the longitudinal plasma current is produced by means of an inductive coupling with the external circuit. The effect of this coupling on the decay of the plasma current is considered. The differential equations describing the equivalent z circuit have two independent solutions; the decay of the plasma current is given by a combination of two exponentials. This may give rise to a rapid decrease or even a reversal of the current. If one more parallel branch is added, the behavior of the plasma current is governed by three characteristic times. With a proper choice of the circuit parameters, it is possible to generate a temporarily rising plasma current (pseudo-power crowbar). The above-mentioned circuits were studied on an analog computer. The results are compared with experiments done in the screw-pinch device SP III. (auth)

8841 (IPP–1/127, pp 209-12) LOW-PRESSURE OPERATION OF A FAST TOROIDAL PINCH. Hirano, K.; Ohi, M.; Kitagawa, S.; Hamada, Y. (Nagoya Univ., Japan). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Electron-beam injection made it possible to operate the fast toroidal pinch down to 2 mtorr in D_2. The minor and major radius of the glass torus is 3 cm and 6 cm, respectively. The maximum toroidal field B_t is 1.5 T and the plasma current of 150 kA can be induced. The magnetic field and the plasma current rise within 2.5 μsec. The decay time of the field is 50 μsec. Various pre-ionization techniques were studied to find the electron-beam injection into the torus most satisfactory. In the screw-pinch operation, stable discharge is realized when the safety factor q is larger than 1.5, in which case the plasma current decreases suddenly when the toroidal field decays to a certain value. The electron temperature and density obtained by means of the laser scattering are about 10 eV and $5 \times 10^{14}/cm^3$, respectively. In the case of the stabilized-pinch mode, the current decay time becomes longer when the B_t field outside the plasma is reversed. Magnetic probe signals indicate that the maximum plasma energy density is 2×10^{-2} joule/cm^3. (auth)

8842 (IPP–1/127, pp 225-8) PULSED HIGH-β TOKAMAK-LIKE SYSTEM WITH RECTANGULAR CHAMBER CROSS SECTION. Atamanov, V. M.; Levadnyi, G. B.; Nasedkin, Yu. F.; Shchedrin, N. I. (Inst. of Atomic Energy, Moscow). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A magnetic system for producing closed, equilibrium, and stable configurations of high-β plasma in a toroidal chamber with rectangular cross section is described. The closed configuration is formed owing to a nonuniform inducing field. Magnetic field distribution obtained with a model and measures eliminating the asymmetry are considered. (auth)

8843 (IPP–1/127, pp 237-40) SOLUTION TO IMAGE-CURRENT PROBLEMS IN HELICAL EQUILIBRIUM TOROIDAL THETA-PINCH EXPERIMENTS. Cantrell, E. L.; Friedrich, O. M. Jr.; Dougal, A. A. (Univ. of Texas, Austin). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A straightforward plasma model of Scyllac is assumed with $\beta \approx 1$ and surface currents confined to a thin annular region. The inductive coupling between the $l = 0,1$ fields and the perturbed plasma column is calculated. From the gradient of this mutual inductance, the body force acting on the plasma column is obtained. The vacuum scalar magnetic potential χ for the $l = 0,1$ fields and the image current contribution is expressed as $\chi = B_0/h\{C_0 I_0(hr) \sin h_z + [C_1 + \psi(z)]I_1(hr) \sin(\theta - h_z)\}$. The function $\psi(z)$ represents the potential from image currents having z periodicity due to the varying $l = 1$ coil-to-wall separation in the land and groove regions. (M.O.W.)

8844 (IPP–1/127, pp 261-4) SIMULATION AND OPTIMIZATION OF THETA-PINCH IMPULSING CIRCUIT PARAMETERS WORKING FROM CUMULATIVE GENERATOR WITH CURRENT

INTERRUPTER. Aleksandrov, V. M.; Baikov, A. P.; Ivanov, V. A.; Iskoldskii, A. M.; Krotman, L. S.; Nesterikhin, Yu. E.; Nesterov, A. A. (Inst. of Automation and Electrometry, Novosibirsk, USSR). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The efficiency of the simulation method was studied with the help of an analog computer. A brief description of the experiment is given. (M.O.W.)

8845 (IPP-1/127, pp 265-8) PARAMETRIC STUDIES OF LINUS, AN ULTRAHIGH MAGNETIC FIELD THETA PINCH. Boris, J. P.; Shanny, R. A. (Naval Research Lab., Washington, D. C.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

Calculations of a theta pinch in which megagauss magnetic fields and thermonuclear fusion plasmas are produced by magnetically imploding a rotating metallic liner are reported. Plasma temperatures greater than 10 keV and number densities greater than $10^{19}/cm^3$ can be sustained for times approaching 10 μsec. (auth)

8846 (LA-DC-72-927) RESULTS FROM THE TOROIDAL Z-PINCH EXPERIMENT ZT-1. Burkhardt, L. C.; DiMarco, J. N.; Forman, P. R.; Haberstich, A.; Karr, H. J.; Phillips, J. A. (Los Alamos Scientific Lab., N. Mex.). 1970. 2p. (CONF-720841-1). Dep. NTIS.

From second topical conference on pulsed high beta plasmas; Grenoble, France (21 Aug 1972).

Magnetic field programming has produced reversal of the B_Z field outside the pinch, with the zero in the field ~0.5 cm from the wall. MHD stability analysis of the magnetic field profiles shows a reduction in the growth rate and range of unstable wave numbers with B_Z reversal. (auth)

8847 (ORNL-TM-4047) MOLTEN SALTS AS BLANKET FLUIDS IN CONTROLLED FUSION REACTORS. Grimes, W. R.; Cantor, Stanley (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 31p. Dep. NTIS.

The blanket of a fusion reactor serves to absorb and transfer the energy of the fusion reaction products, and to produce the tritium necessary to refuel the reactor. This report outlines how these two functions are performed by lithium-bearing molten salts. (M.O.W.)

8848 (ORO-3895-18) HELIOS PROGRAM PROGRESS REPORT. Robertson, Harry S. (Miami Univ., Coral Gables, Fla. Dept. of Physics). 15 Sep 1972. 18p. Dep. NTIS.

Details of this year's progress on the Helios program are outlined. The research includes work on the following: (1) lithium ion source, (2) microwave noise source, (3) waveguide transition and vacuum window, (4) boundary cage, (5) diagnostics, (6) electron heating system, and (7) ion heating studies. (M.O.W.)

8849 USE OF THE VIRTUAL-CASING PRINCIPLE IN CALCULATING THE CONTAINING MAGNETIC FIELD IN TOROIDAL PLASMA SYSTEMS. Shafranov, V. D.; Zakharov, L. E. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 12: No. 5, 599-601 (Sep 1972).

It is assumed that the equilibrium configuration under consideration is surrounded by a closed superconducting sheath S coinciding with one of the toroidal magnetic surfaces. Outside this sheath the magnetic field is zero. The only magnetic field sources are then the current in the plasma and the surface current induced in the superconductor. This virtual-casing principle is used to calculate the confining magnetic field. (M.O.W.)

8850 MEASUREMENT OF ANGULAR SPREADING OF LOW-ENERGY CHARGED-PARTICLE BEAMS IN A NEUTRALIZER CELL. Mallon, R. G. (Univ. of California, Livermore). Nucl. Fusion; 12: No. 5, 601-4(Sep 1972).

As part of the development of low-energy injection equipment for the Adiabatic Low-Energy Injection and Containment Experiment (ALICE), the beam spreading which occurs in a gas cell neutralizer was measured. This spreading results largely from multiple-scattering collisions between beam atoms and neutralizing gas. For these measurements, the neutralizing gases were water and a complex fluorocarbon. Beam particles were protons and deuterons, ranging in energy from 800 eV to 1400 eV. The measurements were made with a beam line and ion source which were not attached to the ALICE experiment. (M.O.W.)

8851 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 6, NO. 9, 1972. Bibliography, Author Index, Subject Index, Appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 45p.

This listing contains 218 references on various aspects of controlled fusion research. (M.O.W.)

8852 FUSION ENERGY. Tuck, J. L. Recherche (Paris); 3: No. 27, 857-72(Oct 1972). (In French).

Energy derived from nuclear fusion appears to be the only means through which the energy requirements of the world's population can be fulfilled. The technological problems of controlled fusion have not yet been solved. Machines currently being investigated are reviewed: tokamak, theta-pinch, mirror, Z-pinch, and laser-fusion. (France)

Wave Phenomena

Refer also to abstract 8209.

8853 (AEC-tr-7371) ABSORPTION OF MICROWAVES BY A PLASMA WHICH IS ESSENTIALLY NONUNIFORM ALONG A MAGNETIC FIELD. Arkhipenko, V. I.; Budnikov, V. N. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated from report NP-19083. 13p. Dep. NTIS.

The plasma was formed under the effect of microwave power in the 3-cm range in the electron cyclotron resonance mode in the initial section of the narrow long container (diameter 2.5 cm, length 70 cm) filled with argon at a pressure of 10^{-2} mm Hg. In the midsection of the container, an exponentially decreasing distribution of the concentration with respect to length was established. Microwaves at a frequency of 2,370 MHz and the power of 0.01 to 10 W were fed to this region of the plasma along a 10-cm waveguide across the axis of the container; the high-frequency electric field was perpendicular to the stationary magnetic field. The plasma parameters are as follows: $n = 10^{10}$ to 10^{12} cm^{-3}, T_e = 2 to 2.5 eV; for the operating frequency, the conditions $\omega_H \approx 3\omega$ and $\omega_p \geq \omega$ were satisfied. Effective absorption of the waves (up to 60%) was detected for average concentrations within the limits of the 10-cm waveguide greater than critical ($n_c = 7 \times 10^{10}$ cm^{-3}). It was established that an increase in the concentration of the initial plasma and, consequently, isolation of the wave energy takes place outside the 10-cm waveguide at distances of 10 to 25 cm. The absorption region of the microwaves is located near the cross section where the maximum concentration n_0 is critical n_c, and it moves along the container together with the displacement of this cross section. It is demonstrated that, under the experimental conditions, a plasma waveguide is formed along which the wave is propagated without noticeable damping to the region $n_0 \approx n_c$. This position of the region of absorption of the waves is discussed on the basis of wave-transformation theory in a plasma with a two-dimensional inhomogeneity. (auth)

8854 (IPP-1/127, pp 65-8) EXCITATION OF WAVES AND RESONANCES IN HIGH-BETA PLASMAS. Grossmann, W.; Tataronis, J. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Jul 1972.

From second topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The problem of the excitation of waves and resonances in nonuniform high-beta MHD plasmas is treated, and it is shown that qualitatively different results are obtained than from the theory of uniform plasmas. (auth)

8855 (UCRL-73378) STIMULATED BRILLOUIN SCATTERING IN PLASMAS. Bodner, S. E.; Eddleman, J. L. (California Univ., Livermore. Lawrence Radiation Lab.). 31 Aug 1971. 16p. Dep. NTIS.

Hydrodynamic equations are used to develop the theory of the decay of transverse radiation into acoustic waves and backscattered Stokes radiation in a nonmagnetized plasma. The power threshold for this instability can be the lowest of any of the known decay modes. For incident radiation with a frequency bandwidth large compared to the acoustic frequency, the Stokes radiation has half the bandwidth of the incident radiation. (auth)

8856 STATIONARY SOLITARY, SNOIDAL, AND SINUSOIDAL ION ACOUSTIC WAVES. Schamel, H. (Max-Planck-Institut fuer Physik and Astrophysik, Munich). Plasma Phys.; 14: No. 10, 905-24(Oct 1972).

The treatment of zero-damped electrostatic waves in a Maxwellian plasma is extended to the nonlinear regime. Stationary Bernstein-Greene-Kruskal modes that propagate with ion acoustic speed are constructed. This subclass consists of solitary, snoidal (periodic waves, like ocean waves, which can be written in terms of Jacobian elliptic functions) and sinusoidal waves. A discrimination of those waves is given by a single parameter, the steepness parameter, which contains nonlinearity, trapping of particles, and dispersion. The soliton of Sagdeev represents a special case of the class of solitons having the largest width and the lowest velocity. (auth)

8857 ION-ACOUSTIC COLLISIONLESS SHOCKS IN A Q-MACHINE. Vanek, V.; Marshall, T. C. (Columbia Univ., New York). Plasma Phys.; 14: No. 10, 925-34(Oct 1972).

An ion-acoustic collisionless shock was observed in a single-ended Q device, operating at a density $\sim 10^9$ cm^{-3}, subsequent to microwave heating of the electrons. A microwave source tuned to electron gyroresonance increased the electron/ion temperature ratio to ~13 without appreciable ionization. The shock was produced by electrically gating a fine-mesh grid immersed in the plasma; the initial downstream/upstream density ratio is ~7. The shock width was less than 4% of the ion-ion mean free path. Comparison of experimental data with numerical solution is given. (auth)

8858 DIRECT AND CROSS POLARIZED BACKSCATTER POWER FROM A TURBULENT PLASMA. Shkarofsky, I. P.; Ghosh, A. K.; Almey, E. N. (RCA Ltd., Quebec). Plasma Phys.; 14: No. 10, 935-50(Oct 1972).

An absolute theory-experiment comparison is provided for radar (16 GHz) backscatter from a turbulent plasma at 45° aspect angle and covering the rms density range from 0.18 to 2 times critical. Both direct and cross-polarized returns are considered. Several theoretical models are developed, such as the Born and second Born approximations, which include reduced attenuation coefficients due to scattering. The optimum reduction factor on the attenuation is found to be 100. The above-mentioned theories agree to within 6.5 dB with the experimental results, considering the whole rms density range and both direct and cross polarization. Experimental backscatter data for a highly overdense turbulent plasma shows that the direct and cross-polarized power returns stay fairly constant above critical density, up to 3.1 times critical. (auth)

8859 QUANTIZATION OF WAVES IN DISPERSIVE MEDIA WITH APPLICATION TO NONLINEAR INTERACTIONS OF PLASMONS. Askne, J. (Chalmers Tekniska Hoegskola, Goteborg). J. Phys., A (London); 5: No. 11, 1578-86(Nov 1972).

Waves in a general dispersive medium represented by a quadratic or bilinear Lagrangian are quantized. A phenomenological method is used, leading to medium excitations in terms of quasi particles (bosons) that are photon-like, phonon-like, etc. The possibility for negative-energy excitations is considered, and interactions between different wave types are studied. The simplicity of the analysis is demonstrated by an analysis of nonlinear interactions in a multistream medium of plasmons. (auth)

8860 ELECTROMAGNETIC WAVES IN MOVING MAGNETOPLASMAS. Chawla, B. R.; Unz, H. Lawrence, KS; University Press of Kansas (1971). 278p. $15.00.

A comprehensive treatment is presented of various aspects of electromagnetic wave propagation in infinite and bounded moving plasmas in the presence of a static magnetic field for both nonrelativistic and relativistic plasma velocities. The characteristic refractive index equations for waves propagating in a moving temperate or warm magnetoplasma are found by using two different models which give identical results. The reflections of normally incident, linearly polarized, plane electromagnetic waves from a semiinfinite temperate magnetoplasma moving through free space or a dielectric medium are investigated. A formal solution of the problem of radiation from electromagnetic sources in the presence of a moving temperate magnetoplasma is obtained from the Lorentzian standpoint. On the basis of a consideration of the Poynting vector in moving plasmas or in general moving polarizable media, it is shown that an interpretation of the Poynting vector as a power flow density should depend on a correct physical interpretation of the Poynting theorem. Based on this and other arguments, the Poynting theorem of the Minkowski theory, as applied to polarizable media, is modified. (IAA)

8861 NONLINEAR PLASMA ION OSCILLATIONS EXCITED BY A CURRENT. Abu-Asali, E.; Al'terkop, B. A.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1293-9(Oct 1972). (In Russian).

The nonlinear stage of development of ion Langmuir oscillations of a plasma excited by a current is investigated just above the system threshold. The time evolution of the amplitude of a linearly unstable wave is studied up to the saturation stage. It is shown that, under the conditions considered, an efficient mechanism restricting amplitude growth is a nonlinear shift of the excited wave frequency. The investigation is carried out for both a weak-collision plasma, in which oscillation buildup is due to the electron Cherenkov effect, as well as for the case of frequent collisions, when the cause of the instability is inverse conductivity and electron diffusion in the plasma with a current. (auth)

8862 BERNSTEIN MODES AND THE QUASICLASSICAL MODEL OF THE QUANTUM PLASMA IN MAGNETIC FIELD. Horing, N. J. M.; Danz, R. W. (Stevens Inst. of Tech., Hoboken, NJ). J. Phys., C (London); 5: No. 22, 3245-52(14 Nov 1972).

A quasiclassical model is employed to calculate quantum magnetic field effects arising in conjunction with Bernstein mode plasmon resonances. This quasiclassical model incorporates Landau quantization effects in connection with degenerate (Fermi-Dirac) statistical averaging, while treating the self-consistent internal plasma dynamics on a classical basis. The limitations of this model are discussed, and its usefulness is assessed. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 7586, 7630, 7637, 7835, and 8222.

8863 (AEC-tr-7370) RESONANCE PHENOMENA DURING MULTIPHOTON IONIZATION OF A XENON ATOM IN AN ELECTRIC FIELD E ~ 5×10^7 V/cm. Alimov, D. T.; Berezhetskaya, N. K.; Delone, G. A.; Delone, N. B. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated from report NP-19085. 7p. Dep. NTIS.

A study was conducted of the eleventh ionization process for a xenon atom by means of a Nd glass laser. The amplitude of the ion signal was determined as a function of the energy of the laser radiation, and the changes in ion yield were measured. The experimental results show that for a field intensity of 5×10^7 volts/cm, the resonance effects play an essential role, whereas effects associated with a virtual transition through strongly excited levels are not manifest. (K.S.W.)

8864 (COO-323-29) FINAL REPORT ON IONIZATION IN GASES FOR PERIOD THRU AUGUST 31, 1972. Jesse, W. P. (Illinois Benedictine Coll., Lisle (USA). Physical Sciences Lab.). 25 Aug 1972. Contract AT(11-1)-323. 12p. Dep. NTIS.

Ionization measurements in water vapor with beta particles were carried out. Also ionization studies in mixtures of argon and mercury vapor are discussed. A pool of mercury was enclosed in an atmosphere of argon in a high temperature test chamber, and the total ionization in the mixture was measured as the vapor pressure of mercury increases with the rising chamber temperature. Ionization plots are given. (M.O.W.)

8865 (GULF-RT-A-12320) ENERGY DEPOSITION STUDIES. Annual Report, September 1, 1971–August 31, 1972. Vroom, D. A. (Gulf Radiation Technology, San Diego, Calif.). 2 Oct 1972. Contract AT(04-3)-167. 60p. Dep. NTIS.

Research on the energy and angular distributions of electrons ejected from atoms and molecules in the gaseous state by energetic radiation is described. The differential secondary electron analyzer and the crossed-beam secondary electron apparatus are described. Experimental results on the secondary electron energy spectra for ionization of argon and water vapor by fast electrons are presented and discussed. (W.H.K.)

8866 ELECTRON TRANSMISSION, ENERGY LOSS, AND RADIATION DAMAGE AT HIGH BEAM VOLTAGES. Cosslett, V. E. (Cambridge Univ., Eng.). pp 165-74 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From 10th symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

Recent development of electron microscopy to high voltages (1 MV and more) has revealed considerable gaps in knowledge of the transmission and energy loss of electrons in thin films. By "thin" is meant here a film thickness equal to a few mean free paths for elastic scattering. The situation is reviewed in order to see how far theory can be relied upon and where further experimental measurements are needed. It will appear that many situations of practical importance for electron microscopy are too complex for any comprehensive theoretical treatment, particularly of energy loss and hence of the limits of observation as set by chromatic aberration. For radiation damage by ejection of atoms from a lattice, however, the predictions of theory accord closely with observation. (34 references) (auth)

8867 EFFECT OF HETEROGENEITY OF A PHANTOM ON THE DISTRIBUTION OF THE ABSORBED DOSE IN LOCAL PROTON IRRADIATION. Voronin, Yu. V. Med. Radiol.; 17: No. 10, 67-70(Oct 1972). (In Russian).

The distribution of absorbed dose during local irradiation by a proton beam was studied as a function of the nonhomogeneity of a phantom (bone, air pockets, etc.) which was intercepted by particles. Narrow and broad beams were included in the investigation, and the intensity of particles at the end of the path measured at the axis of and at the edge of the beam was selected as the criterion for variations introduced by the heterogeneity. The calculations made allowance for multiple scattering. This approach significantly simplified the design and evaluation of radiation effects. (tr-auth)

8868 COMPTON PROFILE OF LiH. Felsteiner, J.; Fox, R.; Kahane, S. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., B; 6: No. 12, 4689-95(15 Dec 1972).

A Compton-profile measurement of polycrystalline LiH was made using 59.54-keV γ rays of ^{241}Am. Fairly good agreement is found with a previous Compton-profile measurement at 17 keV using MoKα x rays. A simple two-parameter theory is used in which a radial phase dependence is introduced for each of the two H^- electrons. Good agreement is obtained with the measured Compton profile and previously measured scattering factors. This is in contrast with previous theories which, though obtaining good agreement with the measured scattering factors, consistently predicted narrower Compton profiles than were experimentally measured. A tight-binding calculation of the Compton profile of LiH was also made using Kunz local-orbital wave functions, which in contrast to previously used simple screened-hydrogenic wave functions have the important feature that first-order overlap was taken into account. The previously neglected Li^+-Li^+ overlaps are shown to be non-negligible and are included. This ab initio calculation, similar to previous theories, predicts a narrower Compton profile than experimentally measured. (auth)

8869 FITTING FUNCTION FOR ENERGY DISSIPATION CURVES OF FAST ELECTRONS. Tabata, Tatsuo; Ito, Rinsuke; Okabe, Shigeru (Radiation Center, Osaka). Nucl. Sci. Eng.; 49: No. 4, 505-6(Dec 1972).

A procedure is presented for determining the energy dissipated by fast electrons at different depths in a variety of materials. The method enables interpolation of the calculated depth–dose profile to account for variations in the atomic number. (auth)

8870 GAMMA-RAY COMPTON PROFILES OF DIAMOND, SILICON, AND GERMANIUM. Reed, W. A.; Eisenberger, P. (Bell Telephone Labs., Inc., Murray Hill, NJ). Phys. Rev., B; 6: No. 12, 4596-4604(15 Dec 1972).

160-keV γ rays were used to measure the Compton profiles of diamond, silicon, and germanium single crystals in five crystallographic directions (⟨100⟩, ⟨110⟩, ⟨111⟩, ⟨112⟩, and ⟨221⟩). The data are analyzed so as to obtain the differences in the profiles in the various directions for each material. A direct comparison of the data is made with band calculations for Si which suggests that the differences in the profiles can provide a sensitive test of band calculations. Interesting comparisons between the three materials are made by normalizing the data to equal electron density for the outer valence electrons. In addition to providing information on the three materials studied, this work demonstrates that systematic studies of families of solid-state systems by Compton scattering can be a very powerful experimental technique. (auth)

8871 GAMMA RAY DOSE IN A CYLINDRICAL PHANTOM. Enz, R. W.; Murphy, H. M. (Air Force Weapons Lab., Kirtland AFB, NM). Health Phys.; 24: No. 1, 53-8(Jan 1973).

A cylindrical phantom was divided into 150 volume elements. The SAMC Monte Carlo code was used to calculate the dose due to beams of monoenergetic gamma rays in each volume element. Calculations were made for 12 source energies between 10 and 0.1 MeV, inclusive. The dose is tabulated for each volume element of the middle layer of the phantom. The results may be used to compute the gamma-ray dose within volume elements of a phantom when the external fluence is known. (auth)

8872 BETA RAY DOSE DISTRIBUTIONS NEAR AN INTERFACE. Cross, F. T. (Battelle-Northwest, Richland, Wash.). Health Phys.; 24: No. 1, 106-10(Jan 1973).

The dose distributions near an interface of dissimilar materials cannot be calculated by the usual methods unless a correction is made for the differences in electron-scattering and energy-loss properties of the apposed materials. Interim approaches for handling these situations are suggested. Although it is most accurate to weigh relative stopping powers (or ranges) by the beta energy spectrum, in most cases it is sufficiently accurate to calculate the ratio for a single energy, e.g., the average energy of the beta spectrum or at 500 keV. The ratio of the atomic numbers can be calculated as in the treatment by Cross. (Phys. Med. Biol.; 13: 611(1968)). (UK)

8873 SPECTRA OF SCATTERED DIAGNOSTIC X-RAYS FROM AN ALDERSON PHANTOM. Waggener, R. G.; Levy, L. B.; Zanca, P. (Univ. of Texas, San Antonio). Health Phys.; 24: No. 1, 59-70(Jan 1973).

The spectra of scattered diagnostic x-rays, at 90° and a distance of 1 m from the central ray of the primary beam, was measured at the side of an Alderson, average man, phantom for a 14 × 17 in. field size. A NaI(Tl) spectrometer system was used to make the spectral measurements. A digital computer was utilized to correct the observed spectrum, $N'_k(E)$, for distortions introduced by

the spectrometer system. The average photon energy, E, derived from the spectrum measurements, and the effective photon energy, E_e, derived from HVL measurements, are compared for the different spectra. Scattered x-ray spectra, normalized to an exposure of one R, are presented in both graphic and tabular form. The shape and average energy of the primary and scattered spectra were found to be very similar. The ratio of the scattered to primary intensity was found to be larger than that commonly used in shielding calculations. Scattered x-ray spectra were measured from 40 to 110 kVp for 0 to 3-mm Al added filters in the primary beam for a typical diagnostic unit. Scattered and primary x-ray spectra are compared in the range 40 to 110 kVp. (auth)

88. ORGANIZATIONAL ASPECTS OF A PERSONNEL DOSIMETRY SERVICE. Rich, B. L.; Samardzich, B. G. (Univ. of California, Livermore). Health Phys.; 24: No. 1, 95-100 (Jan 1973).

Some practical-application aspects of personnel dosimetry are discussed. The following points are made: (1) The ultimate dosimeter does not exist. TLD appears to be the current best choice for most applications. (2) It is improbable that any one dosimeter will serve all needs equally well. (3) Commercial services are valuable to smaller contractors, but larger facilities benefit economically and from a convenience standpoint by providing in-house service. (4) Certain low-risk groups should be placed on an annual or semi-annual frequency for convenience, sensitivity, and economy. Certain difficulties such as background determination and fading should be evaluated for each application. (5) Results from any current personnel dosimeter should be treated as data rather than as the final answer, particularly in significant exposures; professional investigation and evaluations must also be made. (6) Automation reaches an equilibrium point, beyond which further automation is not justified from an economy standpoint. (7) Personnel dosimeter change through in-plant mail is recommended. (8) Much improvement is necessary in record keeping to provide ready access to details required in statistical studies and various types of required reports. (9) An intercalibration organization should be established to foster improved accuracy in calibration and processing, with participation voluntary. (auth)

8875 ABSORBED DOSE AND TISSUE DOSE. Neufeld, J. (Oak Ridge National Lab., TN). Health Phys.; 24: No. 1, 101-3(Jan 1973).

In the new recommendations of the International Commission on Radiation Units and Measurements (ICRU) the definition of the absorbed dose, D, has been revised. An assessment is made, in this communication, of the usefulness of the revised version of D and also of a related quantity D_T, the tissue dose. The main distinction between the old and the new version of D is that the older is macroscopic whereas the newer is microscopic. In spite of the assertion by ICRU the meaning of the two concepts and their range of applicability are not the same. It should be noted that the absorbed dose in health physics is a macroscopic quantity and thus the older definition is preferred. (UK)

8876 IN REGARD TO BOUNDARY CONDITION FOR POINT SOURCE FUNCTIONS OF BETA RADIATION. Radzievskii, G. B. (Inst. of Biophysics, Moscow). Health Phys.; 23: No. 6, 874-6(Dec 1972).

Point source functions (PSF) deal with distribution of average absorbed energy around an infinitesimal beta source immersed into a tissue-equivalent medium. PSF are employed to evaluate beta doses from either radioactive isotopes incorporated in the body or applicators used in radiation therapy. It is pointed out that, in addition to the two conditions already well established, this function demands that there should be a third condition, $W(r) \approx |\overline{dE}/dx|$ where W is the energy absorbed within a spherical layer having unit thickness and radius r and $(\overline{dE}/dx)$ is the averaged value of tissue's (or water's) stopping power for emission spectra. It is stated that the PSF approximations referred to in the literature and also Loevinger's formula do not satisfy this condition. (UK)

8877 ELECTRON DEPTH-DOSE DISTRIBUTION MEASUREMENTS IN METALS AND TWO-LAYER SLABS. Eisen, Harvey A. College Park, Md.; Univ. of Maryland (1972). 113p. University Microfilms Order No. 72-21,115.

Thesis.

Depth-dose distribution measurements were made using broad-beam 2.00-MeV electrons incident on metal slab targets ranging in atomic number (Z) from 13 to 79 and on slabs composed of layers of two different materials. The measurements were based on changes in the absorbance of calibrated radiochromic dye films positioned between disks of the absorbing media. The determination of absolute energy deposition per unit electron fluence was achieved by combining the dose measurement with a measurement of the incident fluence and a stopping-power correction. The stopping-power ratio necessary to convert absorbed dose in the film to absorbed dose in the surrounding medium was evaluated three ways: (1) a computer integration of the stopping powers over the calculated electron energy spectra at various depths; (2) an evaluation of the ratio at each depth of interest using the mean energy of the spectrum at that depth; and (3) using a constant mean value for the entire depth. Data were obtained for aluminum, copper, tin, and gold absorbers at beam incidence angles of 0, 30, and 60°. In addition, measurements were made on 12 two-material slab arrangements involving the combinations polystyrene/copper, polystyrene/tin, and aluminum/gold. Replicate measurements were reproducible within ±5% (2σ) of the mean value. The data for each experiment case are compared to theoretical calculations generated by means of the ETRAN code. In addition, the data taken with the beam at normal incidence are compared to the ionization measurements of Nakai. Agreement with theory is within 10%, and the differences with Nakai's data are examined. (TSS) (Diss. Abstr. Int., B)

8878 AVERAGE GEOMETRICAL FACTOR IN ABSORBED DOSE CALCULATION. Lane, R. G. (Univ. of Wisconsin, Madison); Greenfield, M. A. J. Nucl. Med.; 13: No. 11, 858-9(Nov 1972).

The $\bar{g}$ values were calculated for the major organs of a standard man, based on the organ weights, sizes, and shapes as computed by Snyder, et al. (J. Nucl. Med., 10: Suppl. No. 3, 6-52(1969)). The organs are represented by either spheres or right circular cylinders. The absorbed dose was calculated by using these $\bar{g}$ values and recently published updated physical constants for the radionuclides in conjunction with standard formulas. (M.H.R.)

8879 INVESTIGATION OF A PROGRAM FOR THE CALCULATION OF THREE-DIMENSIONAL DOSE DISTRIBUTIONS WITHIN WATER-EQUIVALENT ABSORPTION MEDIA. COMPARISON WITH EXPERIMENTALLY DETERMINED DATA. von Zwehl, D. Goettingen, Ger.; Goettingen Univ. (1970). 86p. (In German).

Thesis.

A semi-analytical computer program that is based on the system of decrement lines has been tested for its accuracy with regard to the description of real physical absorption conditions for ^{60}Co rays (reliability analysis). The calculated values were found to be in good agreement with values measured on the water phantom. (GF)

8880 DETERMINATION OF ABSORBED DOSES IN THE REGION OF SCATTERED RADIATION OF HIGH ENERGY. Pospelova, I. I. (Leningrad Medical Inst.). Med. Radiol.; 16: No. 10, 54-8(Oct 1971). (In Russian).

A technique is described for determining the value of the absorbed radiation dose in the region of scattering beyond the field during irradiation of patients with high-energy photon radiation. The proposed technique enables the evaluation of the dose in irradiation with fields of different geometrical forms, as well as the use of screening filters during radiation treatment. (auth)

8881 MAXIMUM PATH OF ALKALI METAL IONS IN SINGLE CRYSTALS OF COPPER. Arifov, U. A.; Radzhabov, T. D.; Dzhemilev, N. Kh.; Iskanderova, Z. A. (Inst. of Electronics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 8, 27-30 (1971). (In Russian).

Penetration depths of 5- to 35-keV Li^+, Na^+, and K^+ ions into single crystals of copper were investigated. Separate and distinct curves were obtained in the path–energy graphs for each alkali metal and each orientation: Li⟨100⟩, Na⟨110⟩, Na⟨100⟩, K⟨110⟩, and K⟨100⟩. (K.S.W.)

8882 MEASUREMENT OF TOTAL ATTENUATION COEFFICIENTS FOR 6- TO 10-MeV PHOTONS. Ahmed, K. U.; Cochran, R. G. (Texas A and M Univ., College Station). Nucl. Technol.; 17: No. 1, 66-70(Jan 1973).

Total gamma-ray attenuation coefficients for five different elements (Al, Cu, Fe, Pb, and Zr) were measured for energies 6.02, 7.28, 7.72, 8.49, 9.3, and 9.88 MeV. The nuclear-resonance-scattering method was used in the attenuation of photons for the two energies 7.28 and 8.49 MeV; for the other energies the direct narrow-beam method was used. The total attenuation coefficients were measured with an average uncertainty of 0.6% and appeared to be in better agreement with the tabulated values of Hubbel and Berger (NBS report 8681) than those of Storm and Israel (LA-3753). (auth)

Radiation Source Calibration and Standardization

8883 ABSORBED DOSE AND LINEAR ENERGY TRANSFER DISTRIBUTIONS FROM THERAPEUTIC SOURCES OF ^{252}Cf.

Jones, T. D.; Auxier, J. A. (Oak Ridge National Lab., Tenn.). Phys. Med. Biol.; 17: No. 2, 206-17(Mar 1972).

Calculations of dose and linear energy transfer (LET) were made for various source configurations of ^{252}Cf. Neutrons and γ rays from the spontaneous fission of ^{252}Cf were assumed to originate from a small disk on the surface of the human body or from a point or needle implanted in the body; these are configurations of sources that may be used for treatment of carcinoma (e.g., cancer of the cervix). Distributions of dose and LET are given for these geometries, including the contributions from neutron-produced γ rays. Although the neutron-producing γ radiation was not important close to the source (lower by approximately two orders of magnitude), it contributed an increasing fraction of the dose with increasing distance from the source. (auth)

Shielding Calculations and Experiments

Refer also to abstracts 8506 and 8986.

8884 (ANCR-1066) SELF-SHIELDING IN STACKED FOILS. Nisle, R. G.; Harker, Y. D. (Aerojet Nuclear Co., Idaho Falls, Idaho). Nov 1972. Contract AT(10-1)-1375. 21p. Dep. NTIS.

Both theoretical and experimental work on self-shielding in a stack of 5-mil gold foils is reported. The theoretical work assumes first-flight encounters of neutrons from an isotropic flux in a thin infinite slab. Formulas for the perturbed flux and for the induced activity are derived. Calculated activities are then fitted to the observed activities. This procedure is thus an extension of the sandwich-foil technique. A significant conclusion to be drawn from these results is that this technique provides a means for measuring flux spectra by the use of stacks of foils of relatively few absorbers. The technique does not depend on the existence of an isolated, high-intensity resonance and no correction for background cross sections is needed. A large number of foils of a small number of absorbers replaces a few foils of a limited number of suitable absorbers. Thus, the number of points in a spectrum can be increased beyond the limit fixed by the availability of suitable absorbers. (auth)

8885 (N-72-22666) DOPEX CODE: AN APPLICATION OF THE METHOD OF STEEPEST DESCENT TO LAMINATED-SHIELD-WEIGHT OPTIMIZATION WITH SEVERAL CONSTRAINTS. Lahti, G. P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr 1972. 33p. (NASA-TM-X-2554; E-6799). NTIS.

A two- or three-constraint, two-dimensional radiation shield weight optimization procedure and a computer program, DOPEX, is described. The DOPEX code uses the steepest descent method to alter a set of initial (input) thicknesses for a shield configuration to achieve a minimum weight while simultaneously satisfying dose constraints. The code assumes an exponential dose-shield thickness relation with parameters specified by the user. The code also assumes that dose rates in each principal direction are dependent only on thicknesses in that direction. Code input instructions, FORTRAN 4 listing, and a sample problem are given. Typical computer time required to optimize a seven-layer shield is about 0.1 minute on an IBM 7094-2. (auth)

8886 (N-72-24687) IMPLEMENTATION OF RADIATION SHIELDING CALCULATION METHODS. VOLUME 1. SYNOPSIS OF METHODS AND SUMMARY OF RESULTS. Final Progress Report. Capo, M. A.; Disney, R. K. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec 1971. Contract NAS8-27047. 173p. (NASA-CR-123600; WANL-PR(LL)-40(Vol.1)). NTIS.

The work performed in the following areas is summarized: (1) analysis of realistic nuclear-propelled vehicle was analyzed using the Marshall Space Flight Center computer code package. This code package includes one- and two-dimensional discrete ordinate transport, point kernel, and single-scatter techniques, as well as cross section preparation and data processing codes. (2) Techniques were developed to improve the automated data transfer in the coupled computation method of the computer code package and improve the utilization of this code package on the Univac-1108 computer system. (3) The MSFC master data libraries were updated. (auth) (STAR)

8887 (N-72-24688) IMPLEMENTATION OF RADIATION SHIELDING CALCULATION METHODS. VOLUME 2. SEMINAR/WORKSHOP NOTES. Final Progress Report. Capo, M. A.; Disney, R. K. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec 1971. Contract NAS8-27047. 592p. (NASA-CR-123601; WANL-PR(LL)-40(Vol.2)). NTIS.

Detailed descriptions are presented of the input data for each of the MSFC computer codes applied to the analysis of a realistic nuclear propelled vehicle. The analytical techniques employed include cross section data, preparation, one- and two-dimensional discrete ordinates, point kernel, and single-scatter methods. (auth) (STAR)

8888 EXPERIMENTAL STUDY OF ATTENUATION OF RADIATION IN TUNNELS PENETRATING THE SHIELD OF AN EXTRACTED BEAM OF THE 7 GeV PROTON SYNCHROTRON NIMROD. Stevenson, G. R.; Squier, D. M. (Rutherford High Energy Lab., Chilton, Eng.). Health Phys.; 24: No. 1, 87-93 (Jan 1973).

Measurements are reported of the attenuation of accelerator-produced radiation in large concrete-lined tunnels with clean source geometry using activation detectors and dosimeters. The attenuation in a straight tunnel in full view of the source obeys an inverse square law modified by an exponential air-attenuation factor. The change in particle spectra at a right-angled bend was investigated, and the attenuation of neutron fluence, dose and dose equivalent in the second leg is compared with that predicted from a monoenergetic albedo model. (auth)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 7680, 8222, 8223, 8866, 8881, and 8932.

8889 (ORO-3912-19) COMPUTER EXPERIMENT STUDIES ON MECHANISMS FOR IRRADIATION INDUCED DEFECT PRODUCTION AND ANNEALING PROCESSES. Progress Report, June 1–September 30, 1972. Beeler, J. R. Jr. (North Carolina State Univ., Raleigh). Oct 1972. Contract AT(40-1)-3912. 53p. Dep. NTIS.

Three major topics are considered: (1) differences between the annealing behavior of a displacement spike and a "random" concentrated damage state, (2) electron irradiation, and (3) effects of helium on vacancy cluster stability in α-iron. All concentrated damage states exhibit segregation of vacancies and interstitials. Because the vacancy–interstitial annihilation region is finite, it is not possible to develop a concentrated damage state unless vacancies and interstitials are segregated in the process. It is noteworthy that clustering of vacancies and/or interstitials is not necessary for the development of a concentrated damage state. Annealing of a displacement spike (produced almost instantaneously by a collision cascade) tends to yield more "free" interstitials than "free" vacancies. Annealing of a concentrated "random" damage state, however, can produce either more free interstitials than vacancies or more free vacancies than interstitials. Two programs, DISC and RINGO, were written to simulate damage production and annealing in a high-voltage electron-microscope specimen. DISC computes the displacement cross section. RINGO simulates damage production and annealing. The Wilson–Bisson potential for helium–helium interactions and the Wilson–Johnson potential for iron–helium interactions were used in the DYNAM Program to study stabilization of vacancy clusters by helium. A six-vacancy cluster can be effectively stabilized by one helium atom. A 15-vacancy cluster can accommodate up to four helium atoms. A helium–vacancy complex can be annihilated by spontaneous combination with a [110] self-interstitial. This is made possible by the formation of an intermediate defect, the hybrid helium–iron [111] split-interstitial. (auth)

8890 (PAEC(D)-721) NEUTRON DIFFRACTION MAGNETIC INTENSITIES PROGRAM. Bartolome, L. P.; Akol, M. C. M.; Natera, M. S.; Navarro, Q. O. (Philippine Atomic Research Center, Diliman, Quezon City). Jan 1972. 13p. INIS.

A computer program is presented for the computation of the magnetic intensities of Bragg reflections in neutron diffraction. The program has been prepared in FORTRAN II language for use with a FACOM 230-20/30 machine. The number of reflections in this program are limited to six (6), but these could be increased or decreased as desired by changing a variable in a "do" statement. (INIS)

8891 DEFECTS IN SILICON DURING ION IMPLANTATION. Ikeda, T.; Tsuchimoto, T.; Tokuyama, T. (Hitachi, Ltd., Tokyo). pp 183-8 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From 10th symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

Hydrogen, helium, boron, and argon ions at an accelerating energy of 100 keV and doses 10^{14} to 10^{17}/cm^2 were used to bombard (1$\bar{1}$1)-oriented, n-type, 1 ohm-cm single-crystal silicon substrates. Buried defective zones (overlapping Frenkel-type defects to form amorphous layers) were obtained by electron diffraction and the successive-layer-removal technique. The doses to form the amorphous layer were found to depend on energies and the species of ions; the distribution depths of the defect layers in the substrate surface were also observed to depend on the mass and energy of the ions. Usually, under annealing at suitable conditions, the amorphous layers could be recovered into the perfect lattice, but there were critical doses under which samples are not recovered into single crystal but into polycrystal. In the boron implantation, the annealing was mainly determined by the temperature, not the time intervals, and return to bulk perfection was not assured completely. (L.M.T.)

8892 UNIVERSITY OF COLORADO ION IMPLANTER. Wahlin, L.; Chernow, F. (Univ. of Colorado, Boulder). pp 189-94 of Record of the 10th Symposium on Electron, Ion, and Laser Beam Technology. /Marton, L. (ed.). San Francisco; San Francisco Press, Inc. (1969).

From 10th symposium on electron, ion, and laser beam technology; Gaithersburg, Md. (21 May 1969). See CONF-690571.

The ion implanter described is of the Colutron type. It is capable of implanting any element over an energy range of 5 to 260 keV at beam currents up to 250 μA. The machine, which employs a velocity filter analyzer, has a mass resolution of $M/\Delta M$ over 3000 at half peak height and a cross contamination better than 1 part in 10^{-5} between adjacent masses in the mass-200 region. The unmasked beam size is 0.4 mm in diameter and can carry a current density of 10 mA/cm^2. The implanter also incorporates computer-programmed beam-handling devices for automatic beam writing. Detailed descriptions of the ion source, beam optics, and velocity filter analyzer are given, together with a brief discussion of the vacuum systems. (auth)

8893 CHANGES IN ac CONDUCTIVITY OF SILICON WITH ELECTRON IRRADIATION AT 0.5^{0}K. Gwozdz, P. S.; Koehler, J. S. (Univ. of Illinois, Urbana). Phys. Rev., B; 6: No. 12, 4571-4(15 Dec 1972).

Si was irradiated with 1.5-MeV electrons at 0.5°K. Changes in ac conductivity were dependent upon the dopant in the Si. No significant recovery of ac conductivity was observed with annealing up to 300°K. These results are consistent with previously published results at 1.6°K. These data support the suggestion that athermal migration of the Si interstitial occurs. (auth)

8894 DIPOLAR COMPLEXES IN KCl RESULTING FROM 1.5-MeV-ELECTRON BOMBARDMENT. Stott, J. P.; Crawford, J. H. Jr. (Univ. of North Carolina, Chapel Hill). Phys. Rev., B; 6: No. 12, 4660-7(15 Dec 1972).

The dielectric relaxation behavior of KCl crystals after exposure to 1.5-MeV electrons was studied by means of the ionic-thermocurrent (ITC) method. At least four ITC relaxation peaks at 125, 145, 160, and 195°K are observed over the range from 80 to 200°K after irradiation at 260°K. The irradiation temperature is found to have a strong influence on both the form of the ITC spectrum and the total amount of polarization. The production of dipolar defects, assumed to be responsible for the relaxation, is highest for irradiations in the range 200 to 260°K and it is rather small for exposures at 150 and 300°K. Once produced, the dipolar defects are relatively stable but they can be nearly completely removed by a 400°K anneal. The effect seems to be intrinsic in nature since the total polarization builds up linearly with exposure after the F center has substantially saturated and since it is essentially the same for high-purity crystals from several ingots. Assuming that unit dipoles are responsible for the ITC spectrum, the initial rate of formation is 0.05 times the initial rate of F-center production. Since it is difficult to conceive that such a variety of stable dipoles can be constructed from anion Frenkel defects, it is concluded that defects on the cation sublattice also result from the irradiation. It is shown that the yield of dipoles is at least an order of magnitude higher than can be expected to result from direct displacements induced by electron–ion collisions. The same types of defects may be precursors for the crystallographic voids and dislocation loops observed by electron microscopy in heavily irradiated alkali halides. (auth)

8895 EFFECT OF PLASTIC DEFORMATION ON THE THERMOLUMINESCENCE OF γ-IRRADIATED KCl CRYSTALS. Ausin, V.; Alvarez Rivas, J. L. (Junta de Energia Nuclear, Madrid). Phys. Rev., B; 6: No. 12, 4828-35(15 Dec 1972).

The effect of plastic deformation on the thermoluminescence of nomially pure Harshaw KCl samples γ irradiated at room temperature was studied up to 450°C. In samples plastically strained prior to irradiation, a new glow peak appears. It has been found that this glow peak does not follow either first- or second-order kinetics. It is shown that the phosphorescence decay curves of the glow peak are the superposition of five exponential processes. The activation energies and the preexponential factors of these decays are given. Besides this glow peak, in samples strained after irradiation a glow peak at higher temperatures was observed. It follows second-order kinetics. The study of thermal annealing of the F centers while the temperature of the sample is linearly increased shows that there is an annealing step corresponding to each strain-induced glow peak. These results are discussed in terms of a recently proposed model to explain the thermoluminescence of as-cleaved γ-irradiated samples. In this model the F center behaves as a recombination center for the interstitial atoms thermally released from traps. At some stage in this process, an electron–hole recombination takes place and light is emitted. The relation of these results to the well-known enhancement of the F colorability by ionizing radiation and also to the enhanced thermal stability of the F centers in plastically deformed samples is discussed. (auth)

8896 THRESHOLD FOR RADIATION EFFECTS IN SILICA. Primak, W. (Argonne National Lab., IL). Phys. Rev., B; 6: No. 12, 4846-51(15 Dec 1972).

Data are given for the initial compaction (negative dilatation) of vitreous silica per incident bombarding ion for 40- and 140-keV H^+, D^+, He^+, Ne^+, Ar^+, and 80-keV He^+. The slope of the logarithm of these data plotted against the logarithm of the energy above a threshold value dissipated in nuclear scattering indicates that the threshold energy for the compaction process is very low; much below the typical displacement threshold energy ~25 eV. In contrast, when Hines and Arndt's data for the disordering of quartz in ion bombardment are treated in a similar fashion, a threshold energy ~25 eV is obtained. (auth)

8897 INFLUENCE OF HIGH-ENERGY OXYGEN ION IRRADIATION ON THE CRITICAL CURRENT DENSITY OF SUPERCONDUCTING Nb_3Sn LAYERS. Ischenko, G.; Mayer, H.; Volt, H.; Besslein, B.; Haindl, E. (Univ., Erlangen, Ger.). Z. Phys.; 256: No. 2, 176-84(1972). (In German).

Nb_3Sn diffusion layers were irradiated with 24-MeV oxygen ions at fluences from 3.2×10^{13} up to 1.6×10^{15} cm^{-2}. The enhancement of the superconducting critical current density Δj_c was measured as a function of fluence and of the external magnetic field $H_a(j_c \perp H_a)$. The thermal annealing treatment of the defects concerning the j_c and induced by irradiation was investigated in the temperature region from 200 to 800°C. Results are compared with measurements on irradiated Nb_3Sn with protons and deuterons. Data are discussed in connection with size of defects, cluster distance, flux-line distance, and pinning force. (auth)

8898 ANNEALING OF REACTOR-GRADE GRAPHITE IRRADIATED WITH NEUTRONS AT 350°C; EFFECT ON ELECTRICAL RESISTIVITY AND THERMAL CONDUCTIVITY. Matsuo, H.; Honda, T. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 45: No. 1, 79-81(Oct 1972).

Experiments were conducted on the change of the thermal conductivity (K)-electric resistivity (ρ) correlation by thermal annealing of neutron-irradiated artificial graphite. On a 1/K vs ρ curve, these values decrease with annealing temperature, finally joining into a single line; above 1200°C, 1/K is proportional to ρ. A plot of $K\rho$ is made vs annealing temperature for two different neutron doses; the $K\rho$ value which was decreased by irradiation recovers to the unirradiated value on annealing, with a peak at ~1200-1500°C, whose position depends on the dose. Since ρ does not attain the unirradiated value until 2000°C, the $K\rho$ relation depends on the defects produced by both irradiation and annealing. (D.L.C.)

8899 APPLICATION OF THE ION MICROPROBE ANALYSER TO THE MEASUREMENT OF THE DISTRIBUTION OF BORON IONS IMPLANTED INTO SILICON CRYSTALS. Gittins, R. P. (Univ. of Leeds, Eng.); Morgan, D. V.; Dearnaley, G. J. Phys., D (London); 5: No. 9, 1654-63(Sep 1972).

The distribution in depth of boron ions implanted into silicon crystals was measured using the French "CAMECA" ion-microprobe analyser. Two problems associated with the technique, namely the normalization of the curves and the appearance of a tail on the deeper side of the gaussian, were studied. The technique provides a rapid and simple procedure for profiling, and determines values of projected range which show good agreement with other techniques. (auth)

8900 RADIOLUMINESCENCE OF YTTRIUM-ALUMINUM GARNETS ACTIVATED BY RARE EARTH ELEMENTS. Bagdasarov, Kh. S.; Vakhidov, Sh. A.; Yusupov, A. A. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 2, 26-8(1971). (In Russian).

The radioluminescence and photoluminescence of crystals of $Y_3Al_5O_{12}$ activated by Pr, Tb, Dy, and Er (in 0.5 at.% concentration) were studied by exciting the crystals with ^{60}Co-emitted γ radiation and mercury (or xenon) lamps, respectively, and recording the spectra at 310°K for comparison. An analysis was made of the transitions of the rare earth ions which resulted from each type of excitation. (K.S.W.)

8901 REORGANIZATION OF COLOR CENTERS IN THERMOCHEMICALLY TREATED QUARTZ CRYSTALS. Vakhidov, Sh. A.; Gasanov, E. M.; Khaidarova, Kh. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 4, 25-7 (1971). (In Russian).

The effect of γ and neutron irradiation on color centers of thermochemically processed natural quartz crystals was investigated. Doses of 10^9 R gamma did not produce visually observable coloration in the quartz, but weak signals were detected with a spectrometer at liquid-nitrogen temperatures. Samples subjected to a neutron flux acquired a smoky color which could be bleached out by annealing at 350°C. EPR spectra of the quartz samples were discussed. (K.S.W.)

8902 EFFECT OF DISLOCATIONS ON THE STABILITY OF OXYGEN CENTERS IN SILICON. Azimov, S. A.; Yunusov, M. S.; Kasimova, T. M.; Koropova, P. L. (Physical-Technical Inst., Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 4, 23-5(1971). (In Russian).

The behavior of oxygen in irradiated Si was studied by irradiating samples of Si (specific resistance = from 1 to 700 ohm · cm) at 80°C with 10 R of ^{60}Co gamma radiation. The Si samples, in part, contained dislocations; other samples were dislocation-free. All contained various amounts of oxygen (10^{16} to 10^{17} cm^{-3}). The oxygen was believed to form Si–O complexes. The effects of storage in darkness in vacuum annealing at 400 to 450°C were investigated. (K.S.W.)

8903 RECOVERY OF THE ELECTRICAL RESISTIVITY OF TUNGSTEN FOLLOWING ELECTRON IRRADIATION AT LOW TEMPERATURE. Kunz, W.; Faber, K.; Lachenmann, R.; Schultz, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 7-12 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

High-purity tungsten samples were irradiated with 3-MeV electrons at 4.5K. The isochronal recovery between 10 and 1000K was determined. Several substages of stage I are increased by pre-quenching. From 10 to 45K, no dose dependence of annealing peaks was observed. From 45 to 100K, no final results were obtained. Stage III at 700 to 900 K is dose-dependent according to reaction order two. Stage III annealing overlaps with the annealing of quenched-in vacancies. The size effect parameter was determined to be $k = (18.5 \pm 2)\ 10^{-12}\ \Omega cm^2$. (auth)

8904 ENERGY DEPENDENCE OF ELECTRON INDUCED RADIATION DAMAGE IN TUNGSTEN. Dicarlo, J. A. (Lewis Research Center, Cleveland); Stanley, J. T. pp 13-17 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

The energy dependence of low-dose damage production in commercial and high-purity polycrystalline tungsten wires was studied near 350K with 1.6- to 2.4-MeV electrons. From resistivity measurements at 291K the threshold energy for the onset of observable damage was determined as 50 ± 2 eV (1.62 ± 0.04 MeV). An "effective" threshold of 52 ± 2 eV was also determined by directly fitting the energy dependence of the damage rates to theoretical displacement cross sections calculated from step function displacement probabilities. A decrease of two orders of magnitude in impurity content reduced damage rates by about a factor of two but did not affect threshold. These results combined with current defect recovery models for tungsten, low-temperature threshold data, and computer-calculated bcc damage theory suggest: (1) observed damage consisted of equal concentrations of vacancies and impurity-trapped stage-I free interstitials; (2) minimum recoil energy required for free interstitial production near 0K is 53 ± 5 eV; (3) threshold has little dependence on crystal direction; and (4) the free interstitial fraction of the total irradiation-induced interstitial concentration saturates with increasing recoil energy. (auth)

8905 RECOVERY OF MOLYBDENUM IRRADIATED AT LOW TEMPERATURE WITH ELECTRONS OF DIFFERENT ENERGIES. Afman, H. B. (Univ., Amsterdam). pp 19-21 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Recent results on electron-irradiated molybdenum are presented. Together with data published previously they are used to obtain a model to explain the recovery of molybdenum in the temperature range 15 to 60K. The main feature of this model is the assumption of two defects, the Frenkel pair and an as-yet-unknown defect. The latter accounts for the main recovery peak at 40K. (auth)

8906 RECOVERY OF NEUTRON-IRRADIATED AND COLD-WORKED MOLYBDENUM ABOVE ROOM TEMPERATURE. Stals, L.; Goedeme, G.; Nihoul, J. (CEN, Mol, Belgium). pp 23-31 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

The recovery of molybdenum above 300K following cold work and neutron irradiation ($3 \times 10^{15} < \Phi$ fast n cm$^{-2} < 6 \times 10^{18}$) was studied by means of electrical resistivity measurements at 4.2K. Stages III (~0.16 T_m) and IV (~0.20 T_m) show a negative peak shift, whereas stage V (0.31 T_m) shows a positive peak shift. The apparent reaction order at the peak temperature of stage III changes from a value larger than two to nearly one as the amount of recovery in stage III decreases. The behavior of stages III and IV points to free migration of a point defect, whereas that of stage V is indicative for a complex recovery process. Stage VI (0.36 T_m) is only observed at the highest neutron fluences. Consistent interpretation of the results in the light of the current recovery models is attempted. (auth)

8907 EVIDENCE FOR THE FREE MIGRATION OF INTERSTITIAL DEFECTS IN MOLYBDENUM AT 77 K. Evans, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 33-4 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

In an experimental situation where Frenkel pairs are being created randomly in a lattice and where one of the defects (say the interstitial) is mobile, the retention of defects can be by the trapping of interstitials at impurity traps in the material. By considering the competition between the vacancies and impurity traps for the interstitials, it can be shown that the retained Frenkel pair concentrations, f(r), as a function of the total concentration produced, f(t) is given by: $f(r) = [n_i^2 + 2n_i f(t)]^{\frac{1}{2}} - n_i$, where n_i is the concentration of impurity traps. Using electron irradiation as a convenient method of Frenkel pair production (with $f(t) = \sigma\Phi$ where Φ = electron dose and σ = cross section for Frenkel pair production) it was decided to test this model in molybdenum at 77K by irradiating specimens of different purity and using resistivity methods to measure the retained defect concentrations. The results appear to be completely consistent with the outlined model and point strongly to the existence of a freely migrating interstitial in molybdenum at 77K. (auth)

8908 EFFECT OF ANNEALING ON THE LATTICE PARAMETER AND ELECTRICAL RESISTIVITY OF NEUTRON IRRADIATED NIOBIUM. Doenitz, W.; Hertz, W. (Technische Univ., Darmstadt, Ger.). pp 35-8 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

The recovery of the lattice parameter and the electrical resistivity of niobium after neutron irradiation at 4.6K to a fast fluence of 3.4 to 3.9×10^{18} n cm^{-2} was studied. The corresponding total lattice parameter change amounts to $(\Delta a/a)_0 = 3.45 \times 10^{-4}$ and the total resistivity change is estimated to be $\Delta\rho_0 = 11.5 \times 10^{-7}$ Ωcm. The volume change per Frenkel defect turns out to be (1.0 ± 0.15) atomic volumes, if it is assumed $\rho_F = 1130$ μΩcm /unit concentration. The recovery of the lattice parameter occurs in a number of stages: 32% recovery between 5 and 50K (stage I); 37% between 50 and 170K (stage II); 22% between 170 and 350K (stage III); and 9% above 350K (stage IV). The results seem to indicate the presence of an intrinsic stage III in niobium centered around 205K. (auth)

8909 RECOVERY OF RHENIUM FOLLOWING ELECTRON AND NEUTRON IRRADIATION. Vandenborre, H. (CEN, Mol, Belgium); Stals, L.; Sonnenberg, K.; Nihoul, J. pp 49-54 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Rhenium foils of thickness 10 and 30 μm were subjected to irradiation with 2.8-MeV electrons at 4.5°K, 10-MeV electrons at 370°K, and fast neutrons at 330°K. The annealing behavior was subsequently investigated by means of electric-resistivity measurements at 4.2°K. The induced-resistivity increments varied between 10 and 1800 nΩcm. The low-temperature recovery spectrum after electron irradiation shows at least 5 subpeaks between 20 and 100°K, the most important one occurring at about 90°K for a heating rate of 15°K h^{-1}. Unlike the case of previously performed alpha irradiations, no dose-dependent subpeak could be detected in this range, after electron bombardment to 5 different fluences varying by a factor of 20. The recovery spectra above room temperature following electron and neutron irradiation point to a concentration-dependent recovery stage in the range of about 0.19 T_m (T_m being the melting point), which in analogy with other metals is labeled stage III. The activation energy of this stage is equal to 2.2 eV. (auth)

8910 PRODUCTION AND MUTUAL ANNIHILATION OF FRENKEL PAIRS IN LOW-TEMPERATURE IRRADIATED ZIRCONIUM. Biget, M.; Maury, F.; Vajda, P.; Lucasson, A.; Lucasson, P. (Centre National de la Recherche Scientifique Orsay, France). pp 55-7 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Zirconium was irradiated with electrons in the energy range 0.5 MeV to 1.7 MeV. Electrical resistivity measurements were made with the irradiated sample and an identical reference sample and the difference in voltage drops across them was measured. At 7.5°K the resistivity increase was linear with electron fluence. Also, some recovery measurements were made. The results are quite close to Neely's. Isochronal anneals were made after irradiations at 0.8 and 1.7 MeV. The curves are almost identical. Isothermal anneals were performed and activation energies were determined. (auth)

8911 IRRADIATION DAMAGE IN REFRACTORY METALS. Moser, P. (CEN, Grenoble, France). pp 59-74 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Ten papers were presented about radiation damage in refractory metals. The main topics treated were the enigma of stage I in bcc metals; the classical behavior of other stages in bcc metals; some new aspects of threshold energy measurements; and the enigma of stage I in hcp metals. (France)

8912 DEFECTS IN TUNGSTEN. Galligan, J. M. (Brookhaven National Lab., Upton, NY). pp 241-4 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Point-defect hardening in tungsten is shown to predominantly affect the temperature-dependent portion of the yield stress. The temperature-independent portion of the yield stress is, in contrast, influenced by fast neutrons, which introduce larger damage zones. (auth)

8913 HIGH-TEMPERATURE RECOVERY OF RHENIUM FOLLOWING IRRADIATION WITH 17 keV HELIUM IONS. Sokurski, Y. (Inst. of Atomic Energy, Moscow); Van Guysse, J. pp 303-9 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

An analysis is given of preliminary electron microscope observations on rhenium foils following irradiation with 17-keV He^+ ions. The influence of specimen thickness and dose on dot density has been studied in specimens irradiated to fluences between 10^{14} and 5×10^{17} ions cm^{-2}. This dot density turns out to be nearly constant for specimens of intermediate thickness, while the number of defects is nearly proportional to the logarithm of the fluence. Annealing studies at temperatures up to 1800°C were performed on specimens irradiated to 10^{16} ions cm^{-2}. With increasing temperature one observes a decrease of dot density, an increase of the mean loop size, and a roughly constant total number of defects. These phenomena are explained in terms of interactions between interstitial helium atoms and vacancies. Following annealing at 1500°C, bubbles are first observed. They grow with increasing annealing temperature, but disappear again at 1800°C where a well-developed dislocation network is formed. (auth)

8914 DEFECTS IN GERMANIUM IRRADIATED WITH 1-MeV ELECTRONS AT 85°K. Kraitchinskii, A.; Rzewuski, H.; Suski, J.; Werner, Z. (Inst. of Nuclear Research, Swierk, Poland). Phys. Status Solidi (a); 13: No. 2, 661-8(16 Oct 1972).

Annealing processes in germanium irradiated with a heavy dose of 1-MeV electrons at 85°K and the effect of ionization background upon annealing were studied in the temperature range 85 to 350°K for samples doped with various concentrations of impurities. A general similarity between the annealing behavior of initially n- and p-type germanium samples is noticed. The results are considered to be consistent with the previously proposed models of

an electron trapping center in germanium, assuming the center has the form of a widely spaced Frenkel pair. On the basis of this model, the observed processes are interpreted as a release of vacancies due to the dissociation of Frenkel pairs and their subsequent migration and formation of complexes with impurities and other defects. (auth)

8915 WORK FUNCTION CHANGES OF INDIUM ANTIMONIDE BY IRRADIATION. Lehr, S.; Mantke, W.; Pagnia, H. (Technische Hochschule, Darmstadt, Ger.). Phys. Status Solidi (a); 13: No. 2, K159-61(16 Oct 1972).

Contact potential difference measurements are reported for p-type InSb with real surfaces irradiated by electrons or photons under high vacuum conditions. Irradiation with photons between 298 and 79°K and electrons at 298°K raises the work function, while electron irradiation between 150 and 79°K at low doses caused an increase, and at higher doses, a decrease ($\Delta W = -1$ eV). The ΔW's can be annealed by heating up to 298°K, the negative ones also by illumination. The electron-induced ΔW is independent of electron energy from 25 to 100 eV. The photon-induced ΔW showed a threshold energy of 2.5 eV. Possible explanations are discussed. (D.L.C.)

8916 RECOVERY OF DILUTE Al(Mg) ALLOYS NEUTRON-IRRADIATED AT 4.6°K. Dimitrov, C. (CNRS, Vitry sur Seine, France); Dimitrov, O.; Mayer, H.; Boening, K. Phys. Status Solidi (a); 13: No. 2, K141-3(16 Oct 1972).

The effects of Mg additions (200 and 1000 atomic ppM) on the defect recovery stages in Al were studied after neutron irradiation at two different doses ($\Delta\rho_0 \cong 71$ and 406 nΩ cm). Substage IB is not affected by Mg, whereas substage ID is decreased. The amplitude of substage II A (50 – 110°K) is decreased, while the substage II B (110 – 170°K), absent in pure Al, appears with several substages. The 1000 ppM Mg addition amplifies stage III (>170°K) and shifts it to lower temperatures. (D.L.C.)

8917 MECHANISM OF STAGE III RECOVERY OF ELECTRON-IRRADIATED MOLYBDENUM. Afman, H. B. (Univ., Amsterdam). Phys. Status Solidi (a); 13: No. 2, 623-30(16 Oct 1972).

Resistometric data on Mo, irradiated at room temperature with 2-MeV electrons and annealed at temperatures up to 350°C, are compared with some theoretical models. It is concluded that interstitials migrate during the irradiation and either annihilate at vacancies or cluster around impurity atoms. The recovery is due to the annihilation of vacancies at the interstitial clusters. This conclusion is mainly based on the observed enhancement of the recovery rate with increasing impurity content. (auth)

8918 PULSE IRRADIATION OF DIAMONDS. Barkatt, A.; Ogdan, J. (Hebrew Univ., Jerusalem). J. Phys. Chem. Solids; 33: No. 12, 2217-27(Dec 1972).

The effects of ionizing radiation on type I and type IIa diamonds are investigated using pulse irradiation techniques. A transient absorption is found in both types with peaks around 255, 345, 480, and 600 nm. Its intensity is much stronger than that of the permanent radiation-induced absorption described in the literature. No direct relation is found between the two phenomena upon analyzing the spectrum. The transient absorption of diamonds of both types decays away in two first-order stages with rate constants of $(1.4 \pm 0.2) \times 10^2$ sec^{-1} and (8 ± 3) sec^{-1}. In type I diamonds there is also an initial first-order stage with a rate constant of $(4 \pm 1) \times 10^3$ sec^{-1}. Effects of temperature and polarization on the transient absorption are also discussed. An increase in transmission around 600 nm with a half-life of 3 to 4 sec is observed in some type I specimens. Pulse irradiation induced luminescence is also observed. It is identical with the well-known blue band around 440 nm. It decays via a first-order process, with a time constant of $(5.1 \pm 0.7) \times 10^{-3}$ sec. Deviations from first-order are found in type IIa diamonds. (auth)

Physical Properties

Refer also to abstracts 7840, 7890, 7891, 8490, 8868, and 8912.

8919 (CALT-767-P-3-27) STUDY OF DISLOCATION MOBILITY AND DENSITY IN METALLIC CRYSTALS. Annual Summary Report No. 10 for the Period Ending July 1972. Vreeland, T. Jr.; Villagrana, R. E.; Jassby, K. M. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). [nd]. Contract AT(04-3)-767. 10p. Dep. NTIS.

The current status of research on dislocation mobility and density in metallic crystals is presented, and a summary of the work accomplished since the last reporting period (July 1971) is given. The research has as its objective a first-principle understanding of dislocation origin and behavior. The experimental phase of the work is directed toward measurements of the response of isolated dislocations or groups of dislocations to stresses applied under controlled conditions. The dislocations are observed by x-ray topography, transmission electron microscopy, and etch-pit methods. The theoretical phase applies solid-state theories to predict the strength of the interactions between moving dislocations and lattice phonons, electrons, and crystal defects. The results of studies on Cu, Pb, and Zn are reported. (P.C.H.)

8920 (UCLA-34-P-201-2) FOURIER SPACE COMPUTER SIMULATION OF CRYSTALLINE IMPERFECTIONS. First Annual Progress Report for January 1, 1972–December 31, 1972. de Fontaine, D. (California Univ., Los Angeles. Dept. of Materials). Sep 1972. Contract AT(04-3)-34. 27p. (UCLA-ENG-7293). Dep. NTIS.

A computer simulation was carried out of defect ordering in the omega ($\beta \rightarrow \omega$) phase transformation in Ti, Zr, and Hf alloys. Fourier-space simulation was performed for tetragonal defect clusters in a Ni-like fcc crystal. Computations were made for the elastic interactions of clusters of spherical dilators and ellipsoidal dilators; results are presented in interaction energy vs defect separation graphs. (D.L.C.)

8921 ELECTRICAL TRANSPORT PROPERTIES OF GRAPHITE ASSUMING LATTICE SCATTERING. Olsen, L. C. (McDonnell Douglas Corp., Richland, WA). Phys. Rev., B; 6: No. 12, 4836-45(15 Dec 1972).

The theory for acoustical phonon scattering in graphite is combined with the appropriate electron band model and the transport theory based on the relaxation-time approximation to calculate electrical conductivity and thermoelectric power along the ab planes. Contributions from both majority and minority carriers are included. Basal-plane electrical conductivity and thermoelectric power data from 50 to 600°C for well-oriented graphite materials are analyzed. Assuming presently accepted values for electron band parameters, including a negative value for γ_2, data for the thermoelectric power cannot be explained as long as the material is considered to be an ideal graphite. Data above 300°K can be fit very well if an acceptor density of 2.2×10^{19} cm^{-3} is assumed with an energy level of 0.01 eV below the majority bands at $k_z = \pm\pi/c_0$. Calculated results below room temperature with this acceptor density agree qualitatively with experiment. It is therefore concluded that either well-ordered graphite materials have ≈1 impurity (or defect) for every 10^4 carbon atoms which acts as an acceptor, or refinement of the analytical approach is required, including the possibility of considering different values for band parameters. (auth)

8922 MAGNETIC SURFACE STATES IN CADMIUM. Rahn, J. P.; Sabo, J. J. Jr.; Weir, J. E. (Univ. of Washington, Seattle). Phys. Rev., B; 6: No. 12, 4406-12(15 Dec 1972).

Presented are measurements of the low-field (0 to 80 Oe) microwave surface impedance of cadmium. The surface impedance is dominated by transitions between magnetic surface states. The magnetic fields at which these transitions occur were measured as a function of the orientation of the magnetic field in the three principal crystal planes of cadmium. Five distinct series are presented and the ratios of the observed transition fields agree with the Prange–Nee theory. These series are assigned to points on the Fermi surface and the Fermi velocities on the third-band lens are presented. (auth)

8923 HIGH-RESOLUTION MEASUREMENTS OF AUGER-ELECTRON AND PHOTOELECTRON STRUCTURE IN THE SECONDARY-ELECTRON ENERGY DISTRIBUTIONS OF ALUMINUM, NICKEL, AND COPPER. Powell, C. J.; Mandl, A. (National Bureau of Standards, Washington, DC). Phys. Rev., B; 6: No. 12, 4418-29(15 Dec 1972).

Measurements are reported of selected structure in the secondary-electron energy distributions of evaporated aluminum, nickel, and copper. The specimens were bombarded with 3-keV electrons and the secondary structure was measured with a resolution of 0.1 eV. For each metal, it was hoped to measure Auger transitions involving two relatively narrow inner-shell levels and the valence band in order to obtain information on the valence-band density of states. Attempts were made to observe the Al $KL_{2,3}M$ Auger-electron energy distribution expected at about 1470 eV. Structure was, however, observed with a high-energy edge of 1485.9 ± 0.5 eV and a breadth of 8 to 9 eV. This structure was interpreted as being due to photoemission of valence electrons by internally generated Kα x rays and was similar to uv photoelectron energy distributions and to the calculated density of states. Inelastic scattering of the photoelectrons obscures the expected Al $KL_{2,3}M$ structure. Auger-electron peaks in the ranges 730 to 800 and 820 to 865 eV were measured in the secondary-electron energy spectra for nickel and copper, respec-

tively. Structure was observed in the $L_3M_{2,3}M_{4,5}$ Auger transition (over a range of about 20 eV) that could be associated in part with the final atomic states and in part with over-all features of the 3d-band density of states as determined by soft-x-ray-emission spectroscopy and x-ray photoelectron spectroscopy. It is believed that Auger-electron spectra can yield useful data on changes of electronic structure (e.g., by alloying or by compounding) but, in general, density-of-states data cannot be derived from the Auger spectra without detailed knowledge of the final states expected after the Auger transition of interest. (auth)

8924 LATTICE DYNAMICS OF YZn. Prevender, T. S.; Sinha, S. K.; Smith, J. F. (Ames Lab., IA). Phys. Rev., B; 6: No. 12, 4438-45(15 Dec 1972).

Phonon dispersion curves for YZn along the (0,0,ξ), (ξ,ξ,0), (ξ,ξ,ξ), and (½,½,ξ) directions were measured by inelastic neutrons scattering at room temperature. A sixth-neighbor force-constant model was used to obtain a fit to the data; there is residual indication of weak forces of still longer range. The frequency distribution function, Debye temperature as a function of temperature, and mean-square atomic displacements were calculated from the model. No Kohn-type anomaly was observed, and YZn was not found to become superconducting down to 1.2°K. Comparison of the dispersion curves of YZn with those of β-brass shows some pronounced differences, though there is a coincidence of accidental degeneracy between the transverse acoustical and transverse optical branches in both materials at (0,0,½). (auth)

8925 GROUP-THEORETICAL SELECTION RULES IN INELASTIC NEUTRON SCATTERING WITHIN THE RIGID-MOLECULE MODEL. Casella, R. C. (National Bureau of Standards, Washington, DC); Trevino, S. F. Phys. Rev., B; 6: No. 12, 4533-9(15 Dec 1972).

The model-independent technique of Elliott and Thorpe (ET) is extended to apply to a class of models in which molecular units undergo translational vibrations with respect to each other and also librations, but in which the internal vibronics of the molecules are neglected. Within the model it is found that the ET "structure function" $F^{(r)}(\vec{k})$, associated with irreducible representation r and momentum transfer $\vec{k}$, can be written in the form $F^{(r)}(\vec{k}) = F^{(r)}(\vec{k}|R) + F^{(r)}(\vec{k}|\theta)$, where R and θ signify translational and rotational oscillations. Moreover, the translational part is identical to that of ET except that the atomic scattering lengths a_n which appear in their result are to be replaced by $\vec{k}$-dependent molecular form factors $a_n(\vec{k}')$. $F^{(r)}(\vec{k}|\theta)$ contains a vector form factor equal to $i\vec{\nabla}_{\vec{k}'}a_n(\vec{k}')$, where $\vec{k}'$ is related to $\vec{k}$ via a rotation. Mathematically, their result is contained in ours as a special case. Physically, it is indicated how to use both procedures in concert, thereby aiding in the identification of r as well as in separating the internal from external vibrations and among the latter, the translational and rotational parts thereof. At the Brillouin-zone boundary, the so-called multiplier representations are used, thereby achieving a simplification both of our results and theirs. By significantly reducing the number of phonon modes to be considered in complex molecular crystals, the diagnostic power of this method was likewise increased which requires no detailed knowledge of force constants. It is hoped that the results will receive wide application in the identification of phonons in such crystals. (auth)

8926 TEMPERATURE-DEPENDENT ELECTRONIC TRANSITION IN CERIUM HYDRIDE. Libowitz, G. G.; Pack, J. G.; Binnie, W. P. (Kennecott Copper Corp., Lexington, MA). Phys. Rev., B; 6: No. 12, 4540-6(15 Dec 1972).

Resistivity measurements of single crystals of cerium hydride as a function of temperature revealed resistivity anomalies at about 250°K, which may be associated with a previously reported compositional metal-to-semiconductor transition. Precise x-ray diffractometry disclosed that the cubic fluorite-type structure of cerium hydride becomes slightly tetragonal below 250°K. Neutron-diffraction investigations showed no apparent ordering of excess hydrogen atoms in octahedral interstices and magnetic-susceptibility measurements showed no magnetic ordering. Results of thermoelectric-power measurements are in agreement with a model involving the formation of a defect band to explain the metallic behavior of cerium hydride. (auth)

8927 HIGH-PRESSURE RESISTANCE–TEMPERATURE BEHAVIOR OF BCC YTTERBIUM. Katzman, Howard; Mydosh, J. A. (Kernforschungsanlage, Juelich, Ger.). Z. Phys.; 256: No. 4, 380-6(1972).

The temperature dependence of the electrical resistivity of bcc Yb was measured from 1.3 to 100°K at pressures between 50 and 160 kbar. The resistive behavior is similar to that of a "normal" metal without any indications of superconductivity or magnetic effects. The latter suggests that bcc Yb is divalent. (auth)

8928 MEASUREMENTS ABOUT THE EFFECT OF GRAIN BOUNDARIES ON THE ELECTRICAL RESISTIVITY OF URANIUM DIOXIDE. Schikarski, W.; Ondracek, G. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 45: No. 2, 171-3 (Nov 1972).

Two types of UO_2 having the same stoichiometry (O/U ratio = 1.96 to 1.98) but different grain sizes were prepared by varying the heat treatment of extruded compacts of the same powder. The total internal surface (grain boundary area) per unit test volume of UO_2 was twice as large in the fine-grained UO_2. The resistivity of the coarser grained UO_2 was found to be approximately one order of magnitude higher than the finer grained UO_2 over the entire temperature range (25 to 200°C). It is concluded that the conductivity of the bulk material is improved by the grain boundaries. (D.L.C.)

8929 MAGNETIC SUSCEPTIBILITY OF SOME Au–V ALLOYS. Van Dam, J. E.; Gubbens, P. C. M.; Van den Berg, G. J. (State Univ., Leiden). Physica; 61: No. 3, 389-420(1 Oct 1972).

The magnetic susceptibility of some Au–V alloys (0.2, 0.3, 0.5, 1.0, 2.0 and 10.0 at.%V) was measured from 2 to 293°K. The temperature dependence of the impurity susceptibility of the most dilute samples (0.2 and 0.3 at.%V) can be described, for $T < 50°K$, by $\chi(T) = \chi(0)(1 - AT^2)$. This result is discussed in the light of existing theoretical predictions for the behavior of a Kondo system. It turns out that the magnetic susceptibility can be considered to arise from a virtual bound state having a width comparable to kT_K. Results for more concentrated alloys indicate the existence of V atoms with stronger and weaker local magnetic properties than isolated V atoms. It is suggested that this concentration-dependent behavior can be explained by assuming that nearest-neighbor V atoms have a decreased local susceptibility, while next-nearest V atoms show an increased local susceptibility. 75 references. (auth)

8930 DIRECT OBSERVATION OF AN AMORPHOUS SPIN-POLARIZATION DISTRIBUTION. Rhyne, J. J.; Pickart, S. J.; Alperin, H. A. (Naval Ordnance Lab., Silver Spring, MD). Phys. Rev. Lett.; 29: No. 23, 1562-4(4 Dec 1972).

Evidence is presented from neutron-diffraction measurements for the existence of an amorphous spin-polarization distribution in a sputtered rare earth–iron alloy of composition 33 at. % Tb, 67 at. % Fe. (auth)

8931 PARAMAGNETIC SHEET AT THE SURFACE OF THE HEISENBERG FERROMAGNET EuO. Sattler, K.; Siegmann, H. C. (Eidgenoessische Technische Hochschule, Zurich). Phys. Rev. Lett.; 29: No. 23, 1565-7(4 Dec 1972).

Measurements of the spin polarization of photoelectrons from (100) surfaces of "pure" and doped EuO monocrystals reveal a paramagnetic surface sheet existing at temperatures far below the Curie temperature of the bulk. The extra electrons that are introduced on doping produce an increase of the molecular field in the surface. $Eu_{1-x}La_xO$ crystals exhibit the highest degree of spin polarization (~80%) observed in a photoemission experiment so far. (auth)

8932 PROCEEDINGS OF THE INTERNATIONAL DISCUSSION MEETING ON DEFECTS IN REFRACTORY METALS, MOL, BELGIUM, SEPTEMBER 20–22, 1971. de Batist, R.; Nihoul, J.; Stals, L. (eds.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972). 403p. (CONF-710905).

Abstracts are included for twenty-six papers presented at the subject meeting. Five abstracts have previously appeared in NSA: see NSA 25: 49483 and 49484 and 26: 13393, 23388, and 31559. (J.C.W.)

For abstracts of individual papers see: 8903–8913 and 8933–8947.

8933 THRESHOLD ENERGY FOR DISPLACEMENT IN THE bcc TRANSITION METALS. Dicarlo, J. A. (Lewis Research Center, Cleveland). pp 3-5 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

An empirical method is presented for predicting threshold energies in the bcc transition metals by assuming the directional dependence of threshold is directly proportional to that of Young's modulus. By the use of one universal proportionality constant (1.2×10^{-11} eV cm^2/dyn), thresholds and directions are calculated for Cr, Fe, Mo, Nb, Ta, V, and W and shown to have significantly better agreement with experiment than the best available theoretical estimates. (auth)

8934 QUENCHING AND ANNEALING OF TUNGSTEN. Kunz, W.; Schultz, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 99-105 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Quenching of tungsten in superfluid helium and annealing of the quenched-in vacancies were investigated by resistivity measurements. The formation energy E_{1V}^{f} was determined to be (3.1 ± 0.2) eV; corrections for size effect and infinite quenching speed were applied. Isochronal and isothermal annealing curves show complex kinetics. An upper limit for the migration energy is $E_{1V}^{m} \leq 2.5$ eV. The results are compared with recent self-diffusion data. (auth)

8935 QUENCHING STUDY OF VACANCIES IN MOLYBDENUM. Suezawa, M.; Kimura, H. (Tohoku Univ., Sendai). pp 107-11 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Quenching experiments in molybdenum specimens of different purity are reported. Only in well-purified specimens is a good correlation obtained between the quenched-in resistivity and the quenching temperature. The following vacancy formation parameters are derived: $E_F = 2.9$ eV; $S_F = 0.5$ k. (auth)

8936 QUENCHING OF VACANCIES INTO MOLYBDENUM. Grimes, H. H.; Gotsky, E. R. (Lewis Research Center, Cleveland). pp 113-15 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Results are presented of direct quenching experiments on molybdenum using liquid He-II methods. The 50-μm wire samples used were specially purified and annealed to a resistance ratio of about 1700. Data are presented for quenches from about 1400 to 1900°C at initial quench rates from about 3×10^3 to 1.5×10^4 °C s^{-1}. From the data obtained to date, the best estimate of E_V^f, based on an extrapolation to infinite quench rate is 2.3 eV. (auth)

8937 CARBON PRECIPITATION AND VACANCY ANNEALING IN QUENCHED MOLYBDENUM. Koethe, A.; Burck, P. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). pp 117-24 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

The study of vacancy properties in group-VI bcc metals by quenching and annealing experiments requires detailed knowledge about the possible influence of interstitial impurities, especially carbon, on the effects observed. In the present work high-purity molybdenum single crystals ($0.4 \times 3.5 \times 50$ mm^3) were quenched in high vacuum into gallium–indium–tin after carbon doping, insufficient decarburization, and careful decarburization, respectively. In carbon-doped material (carbon content about 290 at. ppm) the isochronal annealing curve of the electrical resistivity shows several steps between 200 and 1000°C that represent various stages of carbon precipitation. Samples containing only about 2 at. ppm carbon exhibit a large peak around 390°C (supposed to be due to the annealing of carbon-vacancy pairs) and a small one at 560°C. In decarburized material a very small peak is observed at 300°C, a rather continuous resistivity decrease up to 500°C, and a well-developed stage at 560°C. From a comparison of the present results with other data published in the literature, it is tentatively assumed that the 560°C stage (0.29 T_m) is due to divacancies, and the small 300°C stage due to single vacancies. (auth)

8938 QUENCHING OF REFRACTORY bcc METALS. Koethe, A. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). pp 125-52 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

A fast growing interest in investigations of quenched bcc metals now exists. The main reasons for this encouraging development are that test materials of the desired high purity are now available, that our knowledge on the behavior of interstitial impurities in bcc metals has grown to the extent necessary to control their influence in quenching experiments, and that quenching methods have been developed that combine high cooling rates with sufficiently clean conditions. Furthermore, the sensitivity for detection of small vacancy concentrations by means of resistivity measurements has been appreciably increased in the last years. Nevertheless, present knowledge about vacancies in bcc metals is still fragmentary. Experimental values of vacancy formation energies have been published only for tungsten, molybdenum and iron. Recovery measurements have been carried out with tungsten, molybdenum, niobium and iron, but experimentally determined moro-vacancy migration energies were given only for tungsten and iron. (auth)

8939 KINETICS OF POINT DEFECTS ANNEALING IN SOLIDS. Stals, L. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). pp 171-81 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

On the basis of chemical rate equations, the apparent reaction order for interstitial-vacancy recombination with side reactions is computed, and its behavior as a function of concentration is discussed. It is furthermore shown that a kinetic analysis of stage I_E cannot undoubtedly yield arguments for a particular recovery model. (auth)

8940 DIVACANCY MECHANISM OF SELF-DIFFUSION IN bcc TRANSITION METALS. Mehrer, P.; Kunz, P.; Seeger, A. (Univ., Stuttgart). pp 183-91 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

The migration mechanism of divacancies in bcc structures is more complicated than that in fcc structures and is not a priori evident. The divacancy correlation factor will depend on the migration mechanism. If only nearest neighbor jumps occur, the divacancy must go through dissociated configurations, and the correlation factor will depend on whether the dissociated or the nearest neighbor configuration of the divacancy is more stable. An additional possibility for which the correlation factor has also been calculated is that divacancies move by next-nearest neighbor jumps. The results are applied to an investigation of the divacancy contributions to self-diffusion, which will manifest themselves in curved Arrhenius plots for the temperature dependence of the self-diffusion coefficient, and temperature dependences of the isotope effect and the effective activation volumes. Recent measurements on bcc metals are analyzed from these viewpoints. (auth)

8941 IMPURITY CONTROLLED MOTION OF EXTENDED SCREW DISLOCATIONS IN bcc METALS. Wuethrich, C.; Frank, W. (Univ., Stuttgart). pp 193-8 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Recently, Frank and Sestak have suggested interpreting the magnitude of the low-temperature yield stress, its dependence on crystal orientation, and the slip geometry of bcc metals in terms of an impeding of the motion of extended screw dislocations by impurity atoms. First results of a quantitative approach to this model are presented. In particular, the dependences of the yield stress on the temperature of deformation and on the impurity content are treated. (auth)

8942 THEORY OF CRYSTAL DEFECTS. Frank, W. (Univ., Stuttgart). pp 199-215 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

A discussion of diffusion-controlled reactions of point defects in solids, self-diffusion in bcc refractory metals, and the plasticity of bcc transition metals is presented. (auth)

8943 ALLOY SOFTENING IN NIOBIUM- AND TANTALUM-BASE SOLID SOLUTIONS. Ulitchny, M. G.; Sagues, A. A.; Gibala, R. (Case Western Reserve Univ., Cleveland). pp 245-50 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

The phenomenon of alloy softening in bcc alloys, i.e., a reduction of the thermal component of the flow stress with initial additions of solute, is examined with emphasis on recent work on niobium and tantalum alloys. Available information demonstrates that alloy softening observed in these materials has its origin in "scavenging" types of processes, wherein interactions of interstitial impurities with intentionally added alloying elements result in reduced and non-randomly dispersed numbers of obstacles that undergo strong localized interactions with dislocations. (auth)

8944 INTERNAL FRICTION IN RHENIUM. Raadschelders, M.; de Batist, R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). pp 251-5 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

The internal friction spectrum of polycrystalline rhenium is investigated as a function of frequency (between 1 and 400 Hz), thermal treatment, and plastic deformation. The activation parameters of a peak interpreted as being caused by dislocation relaxation are determined ($\tau_0 = 6 \times 10^{-10}$ s; H = 0.38 eV). The temperature where the peak anneals out depends upon the purity of the specimens. The dependence of the yield strength upon the annealing temperature is also studied and the existence of unloading yield point effects in room temperature deformation tests is established. (auth)

8945 REVIEW OF THE CONTRIBUTION MADE BY MICROSCOPY TO THE STUDY OF POINT DEFECTS IN bcc METALS. Eyre, B. L. (Atomic Energy Research Establishment, Harwell, Eng.). pp 311-50 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

A review is given of the study of point defects in bcc metals following particle irradiation and quenching. The experimental techniques, transmission electron microscopy, and field ion microscopy are discussed. Results are given for molybdenum, vanadium, niobium, and tantalum. (auth)

8946 INTERPRETATION OF RECOVERY STAGES IN REFRACTORY METALS. Schultz, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 373-6 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

Comments are presented on annealing data giving evidence for close-pair annihilation and for free migration of point defects in the bcc metals iron, niobium, tantalum, molybdenum, and tungsten. (auth)

8947 INTERPRETATION OF RECOVERY STAGES IN REFRACTORY METALS. Schultz, H. (Univ., Stuttgart). pp 383-94 of Proceedings of the International Discussion Meeting on Defects in Refractory Metals. /de Batist, R. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971). See CONF-710905.

The influence of the crystal structure on the recovery of defects is difficult to specify. Some aspects are similar in fcc, bcc, and hcp materials. Outlines of interpretation are given. Free migration at low temperatures and quenching experiments are discussed. (auth)

8948 ELECTRICAL CONDUCTION OF AMORPHOUS METALS. Lazarev, B. G.; Kuz'menko, V. M.; Sudovtsov, A. I.; Mel'nikov, V. I. (Physical-Technical Inst., Kharkov). Dokl. Akad. Nauk SSR; 206: No. 2, 327-9(11 Sep 1972). (In Russian).

Amorphous modifications of Yb, Fe, Bi, and Be were formed by condensing the respective vapors and then chilling the solids in liquid He. These amorphous phases possess a negative temperature coefficient of resistance. The temperatures of transition from the amorphous to the crystalline state were investigated as functions of the thickness of the films of the metals, from about 20 to 2,000 Å. Crystalline and amorphous materials, and a mixture of the two, are contrasted with respect to their positive or negative changes in electrical resistance with temperature (2 to 14°K). (K.S.W.)

8949 MAGNETIC PROPERTIES OF UTe_2 AND U_7Te_{12}. Suski, W. (Inst. for Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi (a); 13: No. 2, 675-80(16 Oct 1972).

Magnetic measurements on UTe_2 and U_7Te_{12} are performed in the temperature range 4.2 to 1000°K and in magnetic fields up to 80 kOe. U_7Te_{12} appears to be a ferromagnet with the Curie point equal to 73°K. A maximum of the magnetization of U_7Te_{12} is found in magnetic fields below 30 kOe. An attempt to explain the value of the magnetic susceptibility for both compounds is made on the assumption that the ground state is a singlet. 23 references. (auth)

8950 CORRELATION BETWEEN THE WORK FUNCTIONS OF TRANSITION METAL CARBIDES IN THEIR HOMOGENEITY REGIONS AND SURFACE RECOMBINATION OF HYDROGEN ATOMS. Samsonov, G. V.; Podchernyaeva, I. A.; Fomenko, V. S.; (and others) (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 5, 389-92 (May 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 5, 62-6(May 1972).

A study was made of work functions and rates of surface recombination of H atoms for carbides of Groups IV and V metals, with emphasis on TiC_x and NbC_x. Recombination coefficients were also measured for carbides of Zr, Ta, V, Cr, W, and B. The variation of work function and recombination coefficient with composition, which is linear for TiC_x, is discussed using the electronic mechanism of carbide formation and of adsorption reaction. A localization of electrons in sp^3 states is accompanied by an increase in work function and a decrease in recombination coefficient. The recombination coefficient increases in going from Group IV carbides to Group VI carbides. (D.L.C.)

8951 ELECTRICAL RESISTIVITY OF FIBER COMPOSITES. Rybal'chenko, M. K.; Ustinov, L. M.; Zhamnova, V. I. (Inst. of Metallurgy, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 5, 393-5(May 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 5, 67-70(May 1972).

It is shown that the equation for the electric conductivity of fiber composites with unidirectional continuous structure also applies for composites with unidirectional discrete structure. Unidirectional Cu–W wire composites with continuous and discrete structures were prepared with varying volume fraction of fibers and fiber length. Results showed good agreement between experiment and calculation, except for some discrepancies which were attributed to porosity. (D.L.C.)

8952 INTERPRETATION OF FIELD-ION IMAGES FROM ORDERED Ni_4Mo. Chandrasekharaiah, M. N.; Ranganathan, S. (Banaras Hindu Univ., India). Phys. Status Solidi (a); 13: No. 2, 359-70(16 Oct 1972).

A computer simulation procedure with which it is possible to simulate field-ion images from all the thirty domain orientations of ordered Ni_4Mo was devised. It is shown that the shell thickness to be used in the computer simulation of ordered alloys is more than that for pure metal specimens of equal radius. The interaction between prominent planes across domain boundaries in field-ion images of Ni_4Mo is worked out. Evidence for this is presented in the form of simulated patterns. (auth)

8953 ADSORBED BARIUM FILMS ON TUNGSTEN AND MOLYBDENUM (011) FACE. Fedorus, A. G.; Naumovets, A. G.; Vedula, Yu. S. (Inst. of Physics, Kiev). Phys. Status Solidi (a); 13: No. 2, 445-56(16 Oct 1972).

The work function and thermal stability of Ba–W(011) and Ba–Mo(011) systems, as well as the structure of adsorbed barium films on the molybdenum (011) face, are studied. From the structural analysis, data on absolute surface concentration of barium atoms are obtained. The work function, adsorption heat, and some characteristics of barium surface diffusion are found to correlate with the structure of films. Phase transitions in the adsorbed films are observed. (25 references) (auth)

8954 SHUBNIKOV–DE HAAS OSCILLATIONS IN GRAPHITE: SELECTIVE SCATTERING BY CHARGED IMPURITIES. Bender, A. S.; Young, D. A. (Imperial Coll. of Science and Tech., London). Phys. Status Solidi (a); 13: No. 2, 631-6(16 Oct 1972).

The wide variations which are observed in the relative contributions of electrons and holes to the oscillatory magnetoresistance of graphites of different origin may be understood by taking into account the greater scattering power of charged acceptors through an attractive, rather than a repulsive interaction. By comparison with neutron-irradiated graphite, which contains negatively charged acceptors, it is proposed that iron impurities act as positively charged acceptors and thus account for the "hole-domination" of imperfectly purified mineral graphites. (27 references). (auth)

8955 NEUTRON-DIFFRACTION STUDY OF UAsSe AND USbSe. Leciejewicz, J. (Inst. of Nuclear Research, Swierk,

Poland); Zygmunt, A. Phys. Status Solidi (a); 13: No. 2, 657-60(16 Oct 1972).

A neutron-diffraction study of UAsSe and USbSe, both of PbFCl-type crystal structure (space group P4/mnm) was made at 4.2°K and room temperature. The position parameters u and z for uranium and selenium atoms, respectively, were determined for both compounds. Neutron-diffraction patterns taken at 4.2°K revealed that these compounds have simple uniaxial ferromagnetic structure. The magnetic moment of uranium is aligned along the fourfold crystal axis. Its value is (1.5 ± 0.1) μ_B, both in UAsSe and USbSe. (auth)

8956 NATURE OF MAGNETIC ANISOTROPY OF DYSPROSIUM. PARAMAGNETIC SUSCEPTIBILITY OF DYSPROSIUM–GADOLINIUM ALLOYS. Levitin, R. Z.; Perekalina, T. M.; Shlyakhina, L. P.; Chistyakov, O. D.; Yakovenko, V. L. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 63: No. 4, 1401-9(Oct 1972). (In Russian).

The paramagnetic susceptibility of Dy_xGd_{1-x} alloys is measured in the basal plane and along the hexagonal axis (c axis) of the crystal. It is shown that the susceptibility obeys the Curie–Weiss law, the effective magnetic moment being the same in both directions and the paramagnetic Curie temperatures being different. In this case $\Delta\Theta_p = \Theta_{pBP} - \Theta_{pc} > 0$ and increases on increase of the dysprosium content in the alloy. An expression for the paramagnetic susceptibility of a two-component alloy is obtained in the molecular field approximation which takes into account, along with exchange energy, also the single-ion anisotropy and anisotropy due to exchange interaction. A comparison of the experimental dependence of $\Delta\Theta_p$ on the composition of the alloys with the theoretical dependence shows that the alloy anisotropy is single-ion and is due to interaction between the anisotropic 4f-electron charge cloud and crystalline field of the lattice. (auth)

8957 PERTURBED ANGULAR CORRELATION OF GAMMA RAYS. Shirley, D. A.; Haas, H. (Univ. of California, Berkeley). Annu. Rev. Phys. Chem.; 23: 385-414(1972).

This review covers PAC of gamma quanta emitted in nuclear decay. The theory is presented in two parts: an intuitive description of the physical principles, and a general theory using Frauenfelder and Steffen's density matrix–perturbation coefficient formalism. Advances in the applications of PAC to the study of extranuclear properties are reviewed, with emphasis on physical chemistry. Angular correlations in metals, insulators, solutions, and gases are covered. (8 figures, 5 tables, 63 references). (D.L.C.)

8958 INTERNAL VIBRATIONS AND HINDERED ROTATION OF ReH_9^{2-} BY NEUTRON SCATTERING SPECTROSCOPY. White, J. W.; Wright, C. J. (Oxford Univ.). J. Chem. Soc., Faraday Trans., II; 68: No. 8, 1414-22(1972).

The hydrogen amplitude-weighted frequency spectra for the whole ion librations and for intra-ion hydrogen vibrations of ReH_9^{2-} were measured by inelastic neutron scattering spectroscopy for K_2ReH_9 and Na_2ReH_9 at 90°K. Librations about both nonequivalent molecular axes were detected and assigned for each of the two distinct crystallographic sites in K_2ReH_9. In the sodium salt two librational frequencies only were observed, suggesting a single site for ReH_9^{2-} in the structure of this crystal. (auth)

8959 EFFECT OF THERMOMAGNETIC ANNEALING ON THE MAGNETIC PROPERTIES OF 79HM ALLOY. Gertman, Yu. M. Fiz. Metal. Metalloved.; 33: No. 6, 1318-19(Jun 1972). (In Russian).

The effect of thermomagnetic annealing on the magnetic characteristics of composition 79HM (Fe–79.5% Ni–0.8% Mn–0.5% Si–4.3% Mo–0.13% Cu, with traces of P, S, and C) was investigated. The magnetic permeability was determined at a frequency of 50 Hz, and magnetization curves with hysteresis loops were constructed. (K.S.W.)

8960 HALL EFFECT OF GADOLINIUM–YTTRIUM ALLOYS. Fedorov, G. V.; Epifanova, K. I.; Volkenshtein, N. V.; Chuprikov, G. E. (Inst. of Metal Physics, Moscow). Fiz. Metal. Metalloved.; 33: No. 6, 1228-32(Jun 1972). (In Russian).

The Hall effect was evaluated for four Gd–Y alloys (Gd at. %'s 12.4, 27.4, 45.9, and 69.3) over the temperature range 4.2 to 340°K. Features of the field and temperature dependences of the Hall effect were associated with the types of magnetic ordering of alloy structures, which were in turn determined by the alloy composition. (tr-auth)

Moessbauer Effects and NMR

Refer also to abstract 8584.

8961 HYPERFINE FIELD OF ^{99}Tc IN IRON. Raghavan, P.; Raghavan, R. S. (Technische Univ., Munich). Z. Phys.; 256: No. 4, 309-15(1972).

The magnetic hyperfine field at ^{99}Tc impurities in Fe was measured to be $|H_{hf}| = 325$ (7) kGauss at 298 °K. The technique of time-differential perturbed angular correlations on the 181-keV state of ^{99}Tc was used. (auth)

8962 GAMMA RESONANCE PHASE ANALYSIS OF IRON-CONTAINING MATERIALS WITH USE OF SELECTIVE SOURCES. Dolenko, A. V.; Egiazarov, B. G.; Korneev, V. P.; Melik'yan, A. A. Yadern. Priborostr.; No. 15, 66-74(1971). (In Russian).

The application of the Moessbauer effect to the control in the phase structure of materials containing iron is discussed. A γ resonance method of phase analysis, consisting in the measurement of n values of the effect of the resonance absorption in n phases of a material from n sources, is proposed. The radiation spectra from each of the sources is close to those parameters of the resonance absorption spectra of the corresponding phases. An experimental evaluation is made of the feasibility of the method. (tr-auth)

8963 MOESSBAUER STUDIES OF $R(FeCo)_2$ LAVES PHASES. Guimaraes, A. P.; Bunbury, D. St. P. (Univ. of Manchester, Eng.). Notas Fis., Cent. Brasil. Pesqui. Fis.; 18: No. 22, 307-23(1972).

Magnetic hyperfine field and isomer shift measurements in $Y(Fe_{1-x}Co_x)_2$ and $Ho(Fe_{1-x}Co_x)_2$ intermetallic compounds are reported, and the changes in these quantities with concentration are related to changes in the d-moment and in the lattice parameter. The origin of the ^{57}Fe hyperfine fields and the proportionality between field and magnetic moment are discussed by means of a simple model. The Moessbauer spectra of the $Y(Fe_{1-x}Co_x)_2$ compounds show that the direction of magnetization changes from ⟨111⟩ axis (in YFe_2) to ⟨101⟩ in the samples with $x \geq 0.17$. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 8478, 8684, and 8695.

8964 (EURFNR-1050) TABLES OF DISTRIBUTION-FREE UNILATERAL AND BILATERAL CONFIDENCE LIMITS FOR THE QUARTILES. Van der Parren, J. L. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Jul 1972. 16p. (BLG-468). Dep. NTIS (U. S. Sales Only).

Work Performed under United States-Euratom Fast Reactor Exchange Program.

For any univariate continuous parent-population, unilateral and bilateral confidence limits are tabulated for sample sizes n = 4 (1) 150 and a confidence level close to but exceeding 0.95. The exact value of the confidence level is given. The bilateral limits cannot be defined uniquely: one may aim to approach 0.95 as closely as possible, one may also wish to avoid extremely asymmetrical tails, but an overall optimum cannot be found in all cases. For this reason, two intervals are often proposed. By regarding the exact confidence levels (total, to the left and to the right) the reader is better informed and can avoid certain pitfalls. Sometimes, one was tempted to offer three alternatives, but abandoned this procedure for the sake of clear presentation. (auth)

8965 (IFVE-SVM-71-122) SUFFICIENT CONVERGENCY CONDITIONS OF THE KONE VARIATION METHOD. Zhigunov, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The sufficient convergency conditions of the Kone variation method are obtained. They are reduced to the choice of such basis of the trial function expansion for which a norm of discrepancy in the Schroedinger equation does not grow by increasing the number of terms in the trial function expansion by expansion coefficients being looked for from the system of equations of the Kone method. (auth)

8966 HAMILTONIAN SYSTEMS IN RELATIVISTIC DYNAMICS. Droz-Vincent, P. (Institut Henri Poincare, Paris). Nuovo Cim.; 12B: No. 1, 1-10(11 Nov 1972).

Hamiltonian systems are defined in the framework of the multitemporal formulation of relativistic dynamics. It is shown that, according to this definition, no Hamiltonian system of particles can involve interactions. This result does not require Poincaré invariance. (auth)

8967 MAXIMUM NUMBER OF COLLISIONS OF ELASTIC PARTICLES. Synge, J. L. (Dublin Inst. for Advanced Studies). Proc. Roy. Soc. (London), Ser. A; 331: No. 1584, 1-18(21 Nov 1972).

Consider n point-particles, all of the same mass, moving freely in space and interacting only by elastic collisions. There are two degrees of freedom in the outcome of any collision. Let C(n) be the maximum number of collisions possible under Newtonian laws and C*(n) the maximum number possible in relativistic mechanics. The following results are established: C(n) $\frac{1}{2}n(n-1)$, C*(n) $\frac{1}{2}n(n-1)$; C(3) = C*(3) = 3; C(4) = 6 (but only for a certain collision-topology) and C*(4) = 7. The problem of finding C(n) and C*(n) is of interest in kinetic theory and elsewhere. (auth)

8968 VELOCITY OF A WAVE PACKET IN AN ANISOTROPIC ABSORBING MEDIUM. Suchy, K. (CNRS, Saint-Maur-des-Fosses, France). J. Plasma Phys.; 8: No. 1, 33-51(Aug 1972).

The field of a pulsed beam (a "wave packet"), traveling through a medium with moderate absorption, is calculated by the saddle-point method. The packet velocity (i.e., the velocity of the spatial amplitude maximum) has the same direction as a generalization of the group velocity in non-absorbing media. It differs from the absolute value of this velocity by a correction factor depending on the absorption, beam width and pulse duration. This factor is unity for vanishing absorption and infinite beam width. (auth)

8969 NUMERICAL INTEGRATION OF THE 2-LEVEL TIME-DEPENDENT SCHROEDINGER EQUATION. Atkins, P. W.; Gurd, R. C. (Physical Chemistry Lab., Oxford). Chem. Phys. Lett.; 16: No. 2, 265-9(1 Oct 1972).

The numerical integration of the time-dependent Schroedinger equation for a 2-level system is described with particular reference to spin-polarization processes. Nonlinear trajectories, re-encounters, and perturbations time-dependent in the strong mixing region can be investigated. Some typical situations are illustrated and the "anomalous" effect of re-encounters described. (auth)

8970 METHOD FOR STUDYING MODEL HAMILTONIANS. MINIMAX PRINCIPLE FOR PROBLEMS IN STATISTICAL PHYSICS. Bogolyubov, N. N. Jr. International Series of Monographs in Natural Philosophy, Volume 43. New York; Pergamon Press, Inc. (1972). 179p. $15.00.

The treatment covers proof of the asymptotic relations for the many-time correlation functions, construction of a proof of the generalized asymptotic relations for the many-time correlation averages, correlation functions for systems with four-fermion negative interactions, and model systems with positive and negative interaction components. (J.F.P.)

8971 CALCULATION OF QUASI-STATIONARY STATES IN NONRELATIVISTIC QUANTUM MECHANICS. Ramm, A. G. (Leningrad Inst. for Precision Mechanics and Optics). Dokl. Akad. Nauk SSSR; 204: No. 5, 1071-4(11 Jun 1972). (In Russian).

The Schroedinger equation possesses solutions which attain infinity for certain values of the parameter k, these values being the so-called quasi-stationary states and often interpreted as resonance. General methods of calculating quasi-stationary states are presented for an arbitrary, spherically symmetrical finite potential. (K.S.W.)

8972 STATISTICAL MECHANICS AT THE TURN OF THE DECADE. Conference Held at Evanston, Illinois, October 28-29, 1969. Cohen, E. G. D. (ed.). New York; Marcel Dekker, Inc. (1971). 242p. $12.50. (CONF-691071).

Eight invited lectures are included whose topics are: ergodic theory, generalization of Boltzmann equation to higher densities, the C*-algebra approach, the Curie point, phase transitions in ferromagnets, mean field approximation and the method of random fields, superfluids and superconductors, and dynamic phenomena near a critical point. A subject index is included. A separate abstract was prepared for the paper on superfluids and superconductors. (D.L.C.)

For an abstract of an individual paper see: 8472.

REACTOR TECHNOLOGY

Power Reactor Development

8973 PHENIX: A STAGE IN THE INDUSTRIAL DEVELOPMENT OF FAST NEUTRON ELECTRONUCLEAR PLANTS. Carle, R. (CEN de Saclay, Gif-sur-Yvette, France); Megy, J.; Robert, E.; Rozenholc, M. Rev. Fr. Energ.; 23: No. 245, 555-64 (Sep 1972). (In French).

A brief description of the characteristics of the Phenix reactor (power, fuel core, cooling circuits) and the problems encountered during its development and construction indicates that this reactor represents a decisive stage prior to the industrialization of fast neutron type reactors. The experience already acquired enables the next phase to be envisaged. (France)

8974 NUCLEAR ENERGY IN SWITZERLAND. Babaiantz, Christophe. Rev. Fr. Energ.; 23: No. 245, 573-6(Sep 1972). (In French).

Switzerland, which is a country that has always relied on its hydroelectric energy sources, has taken a decisive step towards utilizing thermal energy, particularly thermal energy of nuclear origin. This change and the different stages entailed are presented together with the effect of public opinion on the decisions taken and the risks involved for the future if such undertakings are not implemented with a minimum delay. (France)

8975 DEVELOPMENT OF PRESSURIZED WATER REACTORS AND THEIR APPLICATION. de Ladonchamps, J.; Bebin, J. (Societe Franco-Americaine de Constructions Atomiques, Courbevoie, France). Energ. Nucl. (Paris); 14: No. 4, 280-6 (Jul 1972). (In French).

New installations which could be developed in the near future without any major technological innovations from pressurized water reactors of the type currently in use by Westinghouse and Framatome are discussed: uprated power reactors for 1500 and 1800 MW(e) plants; high output power plants built on floating platforms and towed out to sea and anchored after being tested on dry land, such plants being protected by breakwaters; double purpose plants (electricity generation and desalination of sea water). The installations discussed represent only a few of the possible applications of this type of reactor. Nevertheless all the installations described could be developed in the near future if the state of the market justified such developments. (France)

8976 CURRENT ACTIVITIES AND FUTURE PROSPECTS FOR THE CEA IN LIGHT WATER REACTORS. Benveniste, E.; Delayre, R.; Fonteray, J. (CEN de Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris); 14: No. 4, 273-9(Jul 1972). (In French).

During the forthcoming decades the bulk of the nuclear electrical energy available in France and the rest of the world will be derived from light water reactors. The CEA has acquired considerable experience in the electronuclear field and possesses special experience in the field of light water reactors as a result of its collaboration in the French naval program. The CEA is willing to make available to the French electricity board and French industry the experience acquired in order to ensure the success of work being undertaken in the fields of nuclear fuels, nuclear furnaces, and safety. This experience will also enable the CEA to participate actively in these different fields and in the long term strengthen the position of French industry in various parts of the world. (France)

8977 ARE THERE TRULY NO CONVINCING REASONS FOR NUCLEAR ENERGY? Kuhnt, D. (Rheinisch-Westfaelisches Elektrizitaetswerk, AG, Essen). Atomwirt., Atomtech.; 17: No. 12, 634-5(Dec 1972). (In German).

Arguments are presented against the claim that construction of nuclear power plants is pushed too forcefully in West Germany. The argument considers first a sufficient supply of electricity. Taken into account are the increase in demand and available reserves of fossil fuels and uranium. It is concluded that no alternative exists to the development of nuclear energy. Another consideration is the economic aspect of nuclear power plants. Economics will increasingly favor nuclear energy in the future; not only in West Germany but worldwide. A final aspect is environmental pollution. Considered are radioactivity release in the air, transportation and storage of irradiated material, and waste disposal. (H.B.G.)

8978 PROJECT HHT HIGH TEMPERATURE REACTOR WITH HELIUM TURBINE. Kraemer, H. (Kernforschungsanlage, Juelich, Ger.). Atomwirt., Atomtech.; 17: No. 12, 625-7(Dec 1972). (In German).

On 18 September, 1972, a conference was held at the nuclear research center, Juelich, in which several aspects of the HHT were publicly presented prior to the making of a final decision about the start of large-scale development. The following topics were discussed: significance and goal of the HHT project; present status of development; construction concepts of the HHT installation; present status and future projections about gas turbine techniques; and fuel element concepts. In addition, long term development of the HHT was discussed with regard to production of process heat. (H.B.G.)

Physics and Core Engineering

8979 (CEA-CONF-2086) FORCED CONVECTION BOILING OF SODIUM IN A NARROW CHANNEL. Costa, J.; Charlety, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 7p. (CONF-711103-3). Dep. NTIS (U. S. Sales Only).

From American Institute of Chemical Engineers meeting; San Francisco, Calif. (29 Nov 1971).

Experimental results of a study of forced convection boiling of sodium are presented. The tests were performed under boundary conditions representative of those in a liquid metal cooled fast breeder reactor (LMFBR). Steady state boiling occurred and the pressure drop characteristics of the test section (ΔP versus mass flow-rate or "S" curve) were measured. A method using two electromagnetic flowmeters was used to determine the void fraction and the vapor quality of the two-phase flow. The experimental results are compared with the calculated pressure profile. (12 references) (auth)

8980 (GKSS-71/E/14) ZELGAD, A FAST RUNNING MULTIGROUP TRANSPORT BURNUP CODE FOR INFINITE CYLINDRICAL CELLS BASED ON COLLISION PROBABILITY CONCEPTS. Penndorf, K.; Schulz, G. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 21p. (CONF-710656-1). Dep. NTIS (U. S. Sales Only).

From 12th Dragon countries physics meeting; Geesthacht, West Germany (28 Jun 1971).

The essential features of the program are summarized and the results of some sample cases are given together with SN-calculations of the same subjects. 9 references. (auth)

8981 (JUL-837-RE) NUCLEAR CELL CALCULATIONS FOR THE THERMIONIC CELLS OF THE ITR. Talarek, H. D. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Mar 1972. 51p. (In German). Dep. NTIS (U. S. Sales Only).

A multigroup treatment as well as three-dimensional calculations of the reaction rate distribution are necessary because of the heterogeneity throughout the material zone, which is not always long in comparison with the mean free path of neutrons. This creates an extreme space dependency of the neutron spectrum in the thermionic cell. Discussed are the influence of geometric idealization as well as the treatment with a few condensed energy groups of the cell. The resonance treatment of cross sections contains uncertainties that, quantitatively, are comparable to the methodical errors in a comparison of one-dimensional with two-dimensional cell computations. (tr-auth)

8982 ANALYTICAL INVESTIGATION AND DESIGN OF A MODEL HYDRODYNAMICALLY SIMULATING A PROTOTYPE PWR CORE. Khan, E. U. (Babcock and Wilcox, Lynchburg, VA). Nucl. Technol.; 16: No. 3, 479-80(Dec 1972).

In order to ensure that data from Vessel Model Flow Tests are reliable, it is necessary to simulate hydrodynamically the various reactor components within the vessel, including the core. Modeling of the core is complex because, unlike other internals, a three-dimensional flow distribution must be taken into account. Core simulation criteria were derived from the basic conservation laws governing fluid motion within the rod bundles that constitute the core. Using the criteria derived, along with any constraints imposed by the test loop, methodology for the design of a model core which hydrodynamically simulates the prototype core to a good degree of accuracy was developed. Economic and fabrication considerations were taken into account in selecting the final design. (auth)

8983 PRESSURE DROP CORRELATIONS FOR FUEL ELEMENT SPACERS. Rehme, Klaus (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Technol.; 17: No. 1, 15-23(Jan 1973).

An accurate prediction of the hydraulic losses in multi-rod fuel bundles is necessary for reactor design calculations. Correlations of the pressure drop at the spacers are important for these calculations. Pressure drop correlations are proposed on the basis of numerous experimental investigations, both with grid-type spacers and wire wrapped rod bundles. These correlations are valid over a broad range of flow contractions in the case of spacer grids (15-50%) and a broad range of geometrical parameters with wire wrapped rod bundles, respectively, namely rod bundle parameter: pitch-to-diameter ratio $P/D = 1.125 - 1.417$, wire wrap parameter: lead-to-wrap diameter $H/d_m = 6 - 45$, and number of rods in a rod bundle $n = 7 - 61$ rods. The Reynolds numbers of the investigations under consideration ranged between 10^3 and 3×10^5. 15 references. (auth)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

8984 (AEC-tr-7364) STATUS REPORT ON PROBLEMS OF PRESENT DAY CONVENTIONAL CONTAINMENT. Brosche, D.; Engel, M.; Kirst, O.; Rauschmair, R.; Risse, D.; Tscherner, M.; Wild, E. (Technische Universitaet, Munich (West Germany)). Translated from report MRR-91. 64p. Dep. NTIS.

Containment system design, for water-cooled power reactors is discussed, showing the present knowledge and the resulting problems. Starting with the actual types of containment (full pressure containment and pressure-suppression system) and the accompanying auxiliary systems, problems in connection with strains are treated which result from actions from outside and the consequences from loss-of-coolant accidents, whose mathematical treatment is especially discussed. The mechanical and material problems resulting from these strains are examined. Because of the safety function of the containment those problems which deal with leakage rates are very important. Finally questions are treated which are connected with tests and inspections during the construction and working period. (auth)

8985 (LIB/Trans-444) DESIGN CRITERIA AND CONSTRUCTION PRACTICE OF THE SAFETY CONTAINMENT OF BOILING WATER REACTORS. Koch, E.; Kuschel, D. Translated by W. Buykx (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Nucl. Eng. Des.; 19: 291-314(1972). 31p. Dep. NTIS (U. S. Sales Only).

A survey on design, essential criteria, and function of the containment system for AEG-Telefunken's boiling water reactor product line is given. Safety enclosures of other BWR's are in most aspects similar with respect to the basic design principles, so the review might serve as a guide. The system presented consists of a steel primary containment with pressure suppression pool protected by reinforced concrete, of a leak-tight shell around the primary containment with a reventing system, of a reinforced concrete reactor building as secondary containment and of auxiliary systems for air conditioning and filtering and for decay heat removal. A study reveals that the smallest primary containment is the most economical, because primary containment size governs reactor building dimensions. Since the same fuel elements are being used for all plants—the power being proportional to their number—the height of the reactor pressure vessel is almost independent of thermal power. There seems to be a potential to size pressure suppression containments nearly independently of thermal power. Therefore the limits of compact construction are shown. Design criteria presented for the overall containment system consider access to components for operation, inspection and recurring tests in order to maintain high plant availability. They take into account system lay-out under all possible loads and operating conditions as well as quality assurance. They consider independence, separation and diversification of systems as well as redundancy. The criteria are aimed at system and—as a consequence—environment protection under accident and, if necessary, external hazard conditions. Some new test results and conservatively predicted performance of the containment system under reactor accident conditions are examined, showing margins to keep the system safely under control, even under highly degraded conditions. (29 references) (auth)

8986 WEIGHT OPTIMIZATION OF REACTOR SHIELDING USING TRANSMISSION MATRIX METHODS. Leech, W. D.; Rohach, A. F. (Iowa State Univ., Ames). Nucl. Eng. Des.; 22: No. 1, 161-6(1972).

A quick and accurate method of calculating dose rates outside the primary shield of a nuclear reactor is developed. This method is then used to investigate minimum weight reactor shield configurations. The fast neutron dose at the outside of the shield is obtained by using the removal cross section concept. The thermal neutron distribution in the shield is obtained from the two group diffusion equations using Fermi age theory for the slowing down of the fast neutrons. The primary and secondary gamma rays are treated by transmission matrix techniques. The optimization is carried out by determining the weight of various primary shield configurations and then searching for a minimum weight. Studies are conducted on iron-water slab shields and lead-water slab shields. 12 references. (auth)

8987 VARIABILITY OF DOSE REDUCTION FACTOR AS APPLIED TO REACTOR CONTAINMENT SPRAY SYSTEMS. Hebble, T. L. (Oak Ridge National Lab., TN). Nucl. Technol.; 17: No. 1, 79-81(Jan 1973).

The dose reduction factor is used in the evaluation of containment vessel spray systems that are designed for the removal of atmospheric contaminants in pressurized water reactors. The variability of this factor for the specific removal of elemental iodine is examined. Two aspects of variability are considered. First, a method is given for estimating the variance of the dose reduction factor as a function of two random variables; spray drop diameter and spray drop velocity. Second, an estimate of the variance is based on observations from three repeated Nuclear Safety Pilot Plant runs. (auth)

Cooling Systems

Refer also to abstract 7895.

8988 (ANL-7918) INVESTIGATIONS OF MATERIALS COMPATIBILITY RELEVANT TO THE EBR-II SYSTEM. Ruther, W. E.; Greenberg, S. (Argonne National Lab., Ill.). Jul 1972. Contract W-31-109-eng-38. 39p. Dep. NTIS.

Components removed after years of service in the primary sodium tank of EBR-II showed little evidence of direct interaction with liquid sodium or sodium vapor. The only significant deterioration (of a labyrinth pump-shaft seal) was caused by abrasion of aluminum bronze by an adherent mixture of sodium and sodium oxide rotating with the shaft. Components removed from the seal troughs of the rotating plugs showed no interaction between the bismuth-tin alloy and Types 405 and 304 stainless steel. The cracking of a feedwater-heater relief valve was attributed to a combination of inadvertent sensitization of the Type 325 stainless steel during improper welding and oxygen contamination of the feedwater at that location. Ex-reactor exposure of irradiated, deliberately defected mixed-oxide fuel elements to sodium at temperatures up to 1200°F for 87 days resulted in a maximum diameter increase of 10.3 mils at the defect. Other experiments indicated that no extensive contamination of EBR-II equipment would occur through inadvertent washing of a sodium-logged defected fuel element. Ex-reactor exposure of irradiated boron carbide pellets to 1000°F sodium resulted in the penetration of the pellet by sodium and subsequent loss of material in washing. Unirradiated control pellets were not penetrated in the same exposures. No adsorption-desorption effects were detected on the walls of a 100-ft Type 304 stainless steel sampling line for either oxygen or hydrogen impurities in sodium. A series of experiments showed that pure sodium at 1200°F did not penetrate structurally sound Type 304 stainless steel. Vacuum distillation and flowing water were effective in removing sodium from simulated deep crevices. Anhydrous liquid ammonia and moist argon were not. (14 references) (auth)

8989 (ANL/EBR-60) FINAL SYSTEM DESIGN DESCRIPTION OF THE EBR-II REACTOR HYDRAULIC TEST FACILITY (RHTF). Cerchione, J. D.; McGinnis, F. D.; Long, P. M.; Rice, R. E.; Gopalakrishnan, A. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Oct 1972. Contract W-31-109-Eng-38. 52p. Dep. NTIS.

The design and construction of the EBR-II Reactor Hydraulic Test Facility (RHTF) is described. Rehabilitation of the 0.6-scale model reactor vessel and core used in the original studies of flow distribution in EBR-II and the installation of this equipment into the RHTF are covered. The main justification for the facility is discussed with reference to the need to generate experimental data through the use of hydraulic modeling techniques to enable prediction of detailed flow distributions within EBR-II for any given core loading. Mechanical, electrical, and instrumentation design features are comprehensively described. The plans for utilization of the facility are briefly set forth, and the various phases of the proposed test program and methods for data acquisition and analysis are summarized. The principles of operation, including core-loading changes, startup, routine

operation, and shutdown, are delineated. A brief discussion of safety and hazards considerations is included. (auth)

8990 (EUR-4882) OBSERVATIONS ON SODIUM BOILING INSIDE A COOLING CHANNEL OF A FAST BREEDER REACTOR. Bruzzi, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct 1972. 28p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR FB 40,-.

A general discussion is made of the phenomena of sodium boiling which are important in connection with the safety of fast breeder reactors, from the point of view of transient calculations. Main items are: reactivity worth of sodium voidage, sodium overheating, bubble growth and sodium expulsion. Some of the available numerical methods for boiling sodium channels are illustrated and discussed. (auth)

8991 (GEAP-10207-27) REACTOR PRIMARY COOLANT SYSTEM PIPE RUPTURE STUDY PROGRESS REPORT NO. 27, APRIL-JUNE 1972. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jul 1972. Contract AT(04-3)-189. 58p. Dep. NTIS.

The pipe rupture study is designed to extend the understanding of failure-causing mechanisms and to provide improved capability for evaluating reactor piping systems to minimize the probability of failures. Following a detailed review to determine the effort most needed to improve nuclear system piping (Phase I), analytical and experimental efforts (Phase II) were started in 1965. This progress report summarizes the recent accomplishments of a broad program in (a) fatigue studies through both bench-scale and large-component tests, (b) at-reactor tests of the effect of primary coolant environment on the fatigue behavior of piping steels, and (c) failure probability study of actual reactor piping systems. (auth)

8992 SIGNIFICANCE OF THE HHT STUDIES FOR THE LONG-TERM DEVELOPMENT OF HIGH-TEMPERATURE REACTORS. Schulten, R. (Kernforschungsanlange, Juelich, Ger.). Atomwirt., Atomtech.; 17: No. 12, 629-30(Dec 1972). (In German).

Experiments in computer programs within the HHT project will investigate the physical and chemical aspects of fission product transport in primary and secondary circuits. Also studied will be problems of conducting hot noble gases and of isolating the conduits. With respect to graphite, developmental work will involve dimensional changes through neutron radiation and high temperatures. Particular problems are represented by the heat exchanger, especially hydrogen diffusion from the secondary into the primary circuit. With respect to process heat, a chemical experiment is being conducted with helium heated electrically to 1000°C. Within the heated tube, methane and water are reacted into hydrogen and carbon monoxide. From the experimental results, valuable information should be obtained about the behavior of materials and components. (H.B.G.)

8993 DISTRIBUTION OF TRITIUM IN A PRESSURIZED WATER POWER REACTOR PLANT. Jauho, Pekka (State Inst. for Technical Research, Helsinki); Mattila, Lasse. Nucl. Technol.; 16: No. 3, 472-8(Dec 1972).

A versatile computer program is used to investigate the effects of variation in several essential reactor plant operation parameters, such as coolant leakage rates, reactor power history and the amount and date of organized release, on the distribution of tritium in the primary system process waters of a WWER-type pressurized water power reactor plant. All the primary process waters ultimately reach a tritium saturation activity of 1.5 μCi/cm^3 if no organized release is employed. An annual organized release of about one primary circuit water volume is needed to keep the maximum process water tritium activities encountered during an operation year below 0.5 μCi/cm^3. The date of the annual release period usually has a rather slight effect on process water maximum activities. Hence, the date for release may be chosen so that, for example, the accompanying release of fission and corrosion product activities is minimized. 9 references. (auth)

Fuel Systems and Components

8994 (ANL-7964) INVESTIGATION OF THE DISTRIBUTION OF FISSION PRODUCTS AMONG MOLTEN FUEL AND REACTOR PHASES. PART II. DISTRIBUTION OF FISSION PRODUCTS BETWEEN MOLTEN IRON AND A MOLTEN URANIUM DIOXIDE-BASALT MIXTURE. Fischer, Jack; Mrazek, F. C.; Chasanov, M. G. (Argonne National Lab., Ill.). Oct 1972. Contract W-31-109-eng-38. 16p. Dep. NTIS.

The solubility of UO_2 in molten basalt has been determined at 1550°C to be between 5 and 7 wt % and at 2200°C to be between 50 and 55 wt %. The distribution of some of the more important heat-producing fission products between molten iron and a molten UO_2-basalt mixture has been studied. This has been done to evaluate the use of basalt as a fuel diluent and sacrificial material in an LMFBR and to predict the fission-product heat distribution in such a system. It was found that La, Ce, and Nb were distributed to the molten UO_2-basalt mixture, and Mo and Ru were distributed to the molten-iron phase. (auth)

8995 (JAPFNR-64) THERMAL RATCHET TEST OF CLADDING MATERIAL FOR FAST BREEDER REACTOR. Honda, Yutaka; Yamanouchi, Hidekazu (Mitsubishi Atomic Power Industries, Inc., Omiya (Japan)). Aug 1971. 33p. (PNC-SJ-206-71-12). Dep. NTIS (U. S. Sales Only).

For Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan).

Cladding material will serve in an LMFBR at temperatures up to 700°C under repeated stresses caused by internal gas pressure and thermal stress. Therefore, fuel element design must consider the fatigue strength of cladding. A thermal ratchet test performed to obtain the design data for fatigue deformation is described. For the test a very thin cylindrical hollow specimen (outside dia 30.7 mm, inner dia 30 mm, gage length 120 mm, total length 240 mm) was pressurized by N_2 gas, and cyclic thermal stress was given to the tube wall, then, thermal ratchet strains (radial deformation) were measured. Test conditions included maximum outside temperatures of 500°C, 600°C and 700°C, and temperature differences between the inside and outside of the wall of 50°C and 100°C. From the results, thermal ratchet is assumed to occur under the severe conditions. (auth)

8996 FUEL ELEMENT CONCEPTS FOR THE HHT DEVELOPMENT AND FUTURE STUDIES. Hackstein, K. G. HOBEG, Wolfgang, Ger.). Atomwirt., Atomtech.; 17: No. 12, 628-9(Dec 1972).

The present status of fuel element development for HHT reactors is reviewed. Directions for future developments are outlined. Fuel particles must be improved with respect to containment of fission products. This improvement might be achieved either by additions to the fuel material which absorb the fission products or by the development of special diffusion-resistant coatings such as silicon-carbide. The capability of graphite to retain fission products must be further studied. Since fission product release depends on temperature, the fuel element must be designed in such a way that fuel surface temperatures remain relatively low. (H.B.G.)

8997 FUEL SPECIFICATIONS FOR THE SNR-300. REPERCUSSIONS ON THE MANUFACTURING PROCEDURE FOR FUEL TABLETS. Mueller, N. (NUKEM GmbH., Wolfgang, Ger.). Atomwirt., Atomtech.; 17: No. 12, 610-13(Dec 1972). (In German).

For the fuel tablets of the SNR-300, essentially two alternative variations of specification are debated. They have a decisive influence on selection of the manufacturing procedure. Either the tablets can be sintered in one pressing or with subsequent grinding to the required tolerance. Grain size, the variation of which affects the selection of the manufacturing process, is considered in detail for the two alternatives. The analysis yields boundary conditions which permit assessment of economic factors concerning the two alternatives. (H.B.G.)

8998 VIBRATIONS OF PRISMATIC SHELLS WITH HEXAGONAL CROSS SECTION. Krajcinovic, D. (Argonne National Lab., IL). Nucl. Eng. Des.; 22: No. 1, 43-50(1972).

Presented is an approximate method for the vibration analysis of nuclear reactor subassembly ducts in the form of slender thin-walled polygonal shells with hexagonal cross section. The method is based on the semimembrane shell theory. Inadequacies of this approximate theory are not expected to play a significant role in the determination of fundamental natural frequencies. According to the simplified theory employed, three basic types of motion appear as independent: purely longitudinal vibrations, flexural vibrations and distortional vibrations. (auth)

8999 FORCED-FLOW INTERCHANNEL MIXING MODEL FOR FUEL ROD ASSEMBLIES UTILIZING A HELICAL WIRE-WRAP SPACER SYSTEM. Ginsberg, T. (Argonne National Lab., IL). Nucl. Eng. Des.; 22: No. 1, 28-42(1972).

A forced-flow interchannel mixing model is presented which is applicable to LMFBR fuel assemblies containing helical-wire spacer systems. The model accounts for the directional nature of the interchannel mixing mechanism, and can be incorporated into the COBRA-II and COBRA-III B lumped-parameter computer codes. Predictions based on this model are compared with available experimental data, and with results computed using turbulent

mixing models. Recommendations are made for designing future mixing experiments in rod-bundles containing helical-wire spacer systems. (14 references) (auth)

Operation and Economics

Refer also to abstract 9128.

9000 (TRG-Report-2314) VALUE OF PLUTONIUM IN A COMBINED FAST AND THERMAL REACTOR POWER PROGRAMME. Iliffe, C. E. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1972. 14p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

The plutonium credits of both thermal and fast reactors are examined individually. An attempt is then made to draw some conclusions on the total Pu credit of thermal and fast reactors combined. Arguments are also expressed in simple mathematical terms. The change over from an all-thermal to an all-fast program is then considered. It is concluded that the value of Pu is zero before the introduction of fast reactors but, on their introduction, the value is such that the cost of electricity on a once-through system is equal to that on the system prevailing before the introduction of fast reactors. After this its value should be progressively reduced to zero. (UK)

9001 NUCLEAR ENERGY IN GERMAN ELECTRICITY PRODUCTION OF 1971. Atomwirt., Atomtech.; 17: No. 12, 619-20(Dec 1972). (In German).

In five tables are compiled the primary demands for West Germany in 1971 with respect to coal, oil, natural gas, hydroelectricity, and nuclear energy. The development is depicted for the years 1961 through 1971. Size and design of the power plants is also tabulated for 1961 through 1971. Moreover, projections are made for the years 1972 through 1976. The economic development of electricity production is compiled for the years 1961 through 1971. (H.B.G.)

9002 IMPROVED OBJECTIVE FUNCTION FOR FBR'S OPTIMIZATION STUDIES. Goldschmidt, P. (Electrobel, SA, Brussels). Nucl. Technol.; 17: No. 1, 6-14(Jan 1973).

An analytical function for the fuel cycle cost (FCC) of a fast reactor was developed, that is sufficiently simple to be used as an objective function in applications of optimal control theory, such as Pontryagin's Maximum Principle, but also sufficiently accurate, even for fuel cycle parametric studies. 25 references. (auth)

9003 NATURAL GAS AND NUCLEAR POWER FOR PRODUCING ELECTRICITY. Hondius, H. (N. V. Nederlandse Gasunie, Groningen, Netherlands). Ingenieur (Utrecht); 84: A779-84(8 Sep 1972). (In Dutch).

Referring to a study by Ebasco Services Inc. for N. V. Nederlandse Gasunie, an evaluation is made of the Dutch development of energy in the years 1970–1972. The production of natural gas in the period 1966–1977 is given in relation with different customers. The cost of natural gas, oil, and nuclear energy is evaluated against the units of power plants. Central park units of power plants 800 to 1000 MW(e) are recommended. The conclusions are that in 1977/78 nuclear energy can compete economically with natural gas and oil and it is expected that natural gas will still play a role in the eighties by new combined-cycle units (gas turbine/steam turbine-combinations) where cooling water is scarce at some places. (Netherlands)

Safety and Siting

Refer also to abstract 7687.

9004 (AEC-tr-7342) FURTHER DEVELOPMENT OF THE TECHNOLOGY OF LIGHT WATER-COOLED REACTORS. Final Report. Translation of a German report. 111p. Dep. NTIS.

Single pipe experiments were conducted for the experimental investigation of cooling processes during the refilling of the reactor core of a pressurized water reactor following the design basis accident. The internal diameter of the experimental pipe corresponded to the hydraulic diameter of a subchannel of the reactor core. The heat capacity of the fuel rod was simulated with sintered ceramic cladding. The results indicate the following: In the flooding experiments the temperature of the cladding tube ceases to rise when the cooling medium reaches the lower edge of the hot tube. The time for passing in the downward direction of the Leidenfrost temperature (quench time) decreases with rising pressures and increasing feed volumes. Control experiments with respect to the quench time yielded good agreement with American bundle experiments (FLECHT). During the cooling process pressure and density variations occur. The reproducibility of the single-pipe experiments is good. Spray experiments yielded a substantially lower cooling effect in comparison with flooding tests. Spray cooling results in a retardation of the rise in tube wall temperatures. No general collapse of temperatures in the experimental pipe was observed to maximum temperatures of 1,000°C. (auth)

9005 THEORETICAL ASPECTS OF THE FIELD RADIOLOGICAL MONITORING SYSTEM FOR A REACTOR ACCIDENT. II. OPTIMUM DESIGN PRINCIPLES. Kadokawa, Masayoshi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 6, 357-65(Jun 1972).

In order to determine the most effective arrangement for a network of environmental radiation monitors, their optimal location and design have been studied taking into consideration several essential characteristics of the monitors, that is, the relative frequency of wind flow towards the monitors, population density around the monitors, failure rates of monitoring equipments (the necessity for redundancy), and economical factors. The optimizations are made by introducing an objective function, which is formulated as the probability of detecting a radioactive cloud by a monitoring network in good working condition at the required time. The problem of optimum location of monitors is reduced to that of maximizing the objective function under the constraint of given budgetary limits. Optimal apportionment of redundancy for weak subsystems in the monitoring network is studied by a dynamic programming technique of matrix type developed for the purpose. The concepts and methods developed are also applicable to the design of similar systems in other fields. (auth)

9006 REPLY TO J. D. MURCHLAND'S COMMENT ON A TIME-DEPENDENT METHODOLOGY FOR FAULT TREE EVALUATION. Vesely, W. E. (Aerojet Nuclear Co., Idaho Falls, ID). Nucl. Eng. Des.; 22: No. 1, 170-2(1972).

9007 COMMENT ON A TIME-DEPENDENT METHODOLOGY FOR FAULT TREE EVALUATION BY W. E. VESELY. Murchland, J. E. (Kernforschungschungszentrum, Karlsruhe, Ger.). Nucl. Eng. Des.; 22: No. 1, 167-9(1972).

A previous article by W. E. Vesely shows how to calculate, as functions of time, the unavailability and expected number of failures of a system with repairable components. Its further claim to calculate the probability of at least one failure is questioned. (auth)

9008 FAST REACTOR FUEL INTERACTIONS WITH FLOOR MATERIAL AFTER A HYPOTHETICAL CORE MELTDOWN. Jansen, G. (Battelle Northwest Labs., Richland, WA); Stepnewski, D. D. Nucl. Technol.; 17: No. 1, 85-90(Jan 1973).

The hypothetical accident approach to analysis of fast reactors was applied to the meltdown of an entire core and its interaction with containment floor materials of construction. The objective was to show that penetration can be limited by the use of low melting point fluxing materials and thermal insulation at the pool boundaries. The growth of a hemispherical molten pool composed of fuel dissolved in molten basalt is predicted by a model that includes fuel solubility, internal convection in the pool, and transient conduction into the surrounding solid. Core sizes ranging from 3000 to 20,000 kg were investigated. Tentative conclusions are: A molten pool formed by reactor fuel debris can be shown to reach a manageable limiting size rather than penetration to an indefinite distance in an uncontrolled manner. The use of sacrificial materials in which fuel is soluble reduces pool temperatures by diluting fission product decay heat generators and increasing heat transfer surface. During the first 100-200 hours after meltdown the storage of heat in the molten pool can reduce the fission product heat that appears in the overlying sodium pool by 50 to 75 percent. The use of refractory insulation can reduce the pool size and still maintain temperatures beyond the refractory boundaries at values compatible with ordinary containment structural materials. 23 references. (auth)

Steam and Power Conversion System

9009 CONSTRUCTION CONCEPTS FOR THE HHT INSTALLATION. Mueller, W. (HRB, Cologne). Atomwirt., Atomtech.; 17: No. 12, 630-1(Dec 1972). (In German).

Discussed and schematically depicted are the advantages of high temperature reactors with gas turbines (single-circuit installation) over those with steam turbines (double circuit installations). The integrated construction concept appears feasible for a 1000 MW(e) unit. Practically the entire power plant is contained within a prestressed concrete safety container. The turbo-aggregate is located horizontally in a room underneath the reactor. For checks and repairs, the aggregate can be removed. (H.B.G.)

9010 STATUS AND PROSPECTS OF THE GAS TURBINE TECHNIQUE WITH REGARD TO THE HHT DEVELOPMENT.

Baumann, H. (BST, Mannheim, Ger.). Atomwirt., Atomtech.; 17: No. 12, 627-8(Dec 1972). (In German).

The HHT project aims at the development of a large helium turbine with simple construction involving a rotor on two bearings and one or two steps of compression. Thus far conducted studies showed that 1000 MW(e)/unit can be achieved with this simple design. In future development, priority must be assigned to the following aspects: development and testing of cooling systems for those parts of the helium turbine that are exposed to the high temperatures; development and testing of special alloys that are high heat-resistant and compatible with a helium atmosphere; and elaboration of safety problems including installation and removal of the turbine from the prestressed concrete container. (H.B.G.)

Commercial Power Reactors

9011 (LIB/Trans-441) MECHANICAL DAMAGE IN NUCLEAR AND CONVENTIONAL SIDES OF NUCLEAR POWER STATIONS. Feldmann, J. Translated by A. Bicevskis (Australian Atomic Energy Commission), from Nucl. Eng. Des.; 19: No. 2, 207-19(1972). 24p. Dep. NTIS (U. S. Sales Only).

Following on a short consideration of experiences gained with failures occurring during the erection of nuclear power plants, a survey of the experienced operational failures with nuclear power plants is given. The investigation is based on the analyses of publicized descriptions of operational and failure experiences with 8 BWR power plants, 9 PWR power plants, and 13 gas-cooled power reactor plants. The compilation only considers nuclear power plants larger than 100 MWe in capacity. In total 145 faults in the nuclear and conventional parts of the power systems have been analyzed. An analysis of some individual failure events and repairs is given. The causes and types of failures occurring in nuclear power plants are not essentially different from those occurring in conventional plants. It is shown that repairs can also be done on highly activated system components inside of steel and prestressed concrete reactor pressure vessels. However, such repairs take about 10 fold time as compared with the execution of similar repair works which are not influenced by radiation fields. 5 references. (auth)

9012 JOINT FRENCH NUCLEAR POWER PLANT PROJECTS. Wyart, P. (Electricite de France, Paris). Rev. Fr. Energ.; 23: No. 245, 553-4(Sep 1972). (In French).

The type of contract which associates the EDF (French electricity board) to two Swiss groups and a German society is described. The two groups and the society receive part of the nuclear power produced at the Fessenheim and Bugey sites. (France)

Physics and Core Engineering

9013 (BAW-10038(Rev.1)) PROTOTYPE VIBRATION MEASUREMENT PROGRAM FOR REACTOR INTERNALS (177-FUEL ASSEMBLY PLANT). Thoren, D. E.; Harris, R. J. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Nov 1972. 5p.

In accordance with Safety Guide 20, a vibration measurement program to be used at the Oconee 1 reactor site has been developed. Included in this report are a revised table of contents and a one page appendix citing location of data. (J.M.J.)

9014 (WCAP-7898) LONG-TERM TRANSIENT ANALYSIS PROGRAM FOR PRESSURIZED WATER REACTORS (BLKOUT CODE). (Westinghouse Electric Corp., Pittsburgh, Pa.). Apr 1972. 38p.

A digital computer code, designated as the BLKOUT Code, has been developed for simulating the long-term, time-dependent plant behavior of a pressurized water reactor. The code is characterized by the multi-loop, long-term and wide-range plant simulation with the capability to analyze natural circulation conditions. The code can be used for accident analysis, such as loss of all A.C. power to the station auxiliaries (a station blackout) and loss of normal feedwater. It can also be utilized as a tool for auxiliary system design studies. (auth)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

9015 ANALYTICAL STUDIES OF ELEMENTAL IODINE REMOVAL BY SPRAYS IN THE DONALD C. COOK NUCLEAR PLANT. Milioti, S. J. (American Electrical Power Service Corp., New York); Sherman, A.; Ritzman, R. L.; Gieseke, J. A. Nucl. Technol.; 16: No. 3, 497-508(Dec 1972).

A computerized mathematical model was developed which treats the process of iodine removal from the atmosphere of a multi-volume nuclear reactor containment by aqueous sprays under simulated accident conditions. The model is an extension of earlier work and consists of a set of simultaneous linear first-order differential equations that are solved time incrementally. The rate coefficients are calculated internally and take into account the effects of spray solution chemistry, liquid phase mass transfer resistance, system temperature, spray drop coalescence, spray coverage, spray impingement on internal obstructions, and spray solution recirculation. Results of parameter variation studies with the model reveal that liquid phase mass transfer resistance effects are more important than spray loss mechanisms in controlling iodine removal rates. Comparison of computed predictions with results of experimental spray studies show close agreement with respect to initial iodine removal rates. 14 references. (auth)

Cooling Systems

9016 REPAIRS TO SAINT-LAURENT-1. COMPLETE FILTRATION OF THE CARBON DIOXIDE COOLANT. Feru, J.; Leblond, A. (Electricite de France, Saint-Laurent des-Eaux). Energ. Nucl. (Paris); 14: No. 4, 287-306(Jul 1972). (In French).

Subsequent to the incident that occurred with the Saint-Laurent-1 reactor on 17 October 1969, and involving the melting of 5 fuel elements, work was undertaken to recover uranium from the reactor vessel. However, after these operations were completed, some 5 kg of uranium dust still remained dispersed in the reactor vessel outside the reactor core. In order to minimize the possibility of any further quantities of crude uranium entering the core (this would reduce the efficiency with which burst slugs could be detected), a fine carbon dioxide filter was positioned at the reactor input. The filter unit used can filter 9 metric tons of CO_2/second at a pressure of 26 bars and a temperature of 220 deg. A description is given of the design and specification of the installation, the test carried out on the filtering elements, difficulties encountered during the mounting procedures, the operational results and the problems posed by the periodic replacement of the filtering elements, and improvements made to the original installation. (France)

Operation and Economics

9017 (DOCKET-50003-144) INDIAN POINT STATION, UNIT 1. Investigation of Valve Operators. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 1 Dec 1972. 4p. Dep. NTIS.

9018 (DOCKET-50029-216) YANKEE NUCLEAR POWER STATION. Operation Report No. 142 for the Month of October 1972. (Yankee Atomic Electric Co., Westboro, Mass.). Nov 1972. 10p. Dep. NTIS.

9019 (DOCKET-50171-109) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Coastdown did not Occur During Planned Overspeed Trip Test on November 25, 1972. (Philadelphia Electric Co., Pa.). 5 Dec 1972. 2p. Dep. NTIS.

9020 (DOCKET-50219-222) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Failure of No. 2 Generator to Start and Assume Load. (Jersey Central Power and Light Co., Morristown, N. J.). 7 Dec 1972. 3p. Dep. NTIS.

9021 (DOCKET-50249-176) DRESDEN NUCLEAR POWER STATION, UNIT 3. Valves Malfunction. (Commonwealth Edison Co., Chicago, Ill.). 8 Dec 1972. 5p. Dep. NTIS.

9022 (DOCKET-50254-146) QUAD-CITIES STATION, UNIT 1. Jet Pump Instrument Line Failure. (Commonwealth Edison Co., Cordova, Ill.). 4 Dec 1972. 14p. Dep. NTIS.

9023 (DOCKET-50254-147) QUAD-CITIES STATION, UNIT 1, Details Regarding Drift of Two Primary Containment Isolation System Instruments. (Commonwealth Edison Co., Cordova, Ill.). 5 Dec 1972. 3p. Dep. NTIS.

9024 (DOCKET-50254-149) QUAD-CITIES STATION, UNITS 1 AND 2. Small Fire, Isolation Valve Failed to Close, and Plant Chimney Monitoring System Inoperable. (Commonwealth Edison Co., Cordova, Ill.). 11 Dec 1972. 3p. (DOCKET-50265-137). Dep. NTIS.

9025 (DOCKET-50254–150) QUAD-CITIES STATION, UNITS 1 AND 2. Revised 100 Percent Power Test Program. (Commonwealth Edison Co., Chicago, Ill.). 11 Dec 1972. 6p. (DOCKET-50265–138). Dep. NTIS.

9026 (DOCKET-50255–118) PALISADES PLANT. Control Rod Drive Mechanism No. 26 Inoperative. (Consumers Power Co., Jackson, Mich.). 6 Dec 1972. 2p. Dep. NTIS.

9027 (DOCKET-50255–120) PALISADES PLANT. Leak in Socket Weld and Failure of Nuclear Instrumentation. (Consumers Power Co., Jackson, Mich.). 11 Dec 1972. 3p. Dep. NTIS.

9028 (DOCKET-50255–121) PALISADES PLANT. Change 2. (Directorate of Licensing (AEC), Washington, D. C.). 8 Dec 1972. 6p. Dep. NTIS.

Revised technical specifications are presented concerning a temporary increase in power level to 1870 MW(t). (D.C.C.)

9029 (DOCKET-50263–163) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Request for Waiver of Technical Specification Requirement 4.7.D.1.d. (Northern States Power Co., Minneapolis, Minn.). 7 Dec 1972. 1p. Dep. NTIS.

A request to waive the weekly testing of main steam line isolation valves is presented. (D.C.C.)

9030 (DOCKET-50265–139) QUAD-CITIES STATION, UNIT 2. Failure of Outboard Containment Isolation Valve to Operate. (Commonwealth Edison Co., Cordova, Ill.). 6 Dec 1972. 2p. Dep. NTIS.

9031 (DOCKET-50271–119) VERMONT YANKEE NUCLEAR POWER STATION. Abnormal Occurrences Nos. AO-71-12 and AO-72-13; RO Inquiry Report No. 50-271/72-08Q. (Vermont Yankee Nuclear Power Corp., Rutland). 15 Nov 1972. 12p. Dep. NTIS.

Information is presented concerning excessive radiation in the outside radwaste tanks, reactor operation without monitoring the air ejector off gas, fire in an auxiliary transformer, and increase in the stack release rate. (D.C.C.)

9032 (DOCKET-50271–121) VERMONT YANKEE NUCLEAR POWER STATION. Reactor Pressure Switch Actuated at a Pressure Less Than 335 psig. (Vermont Yankee Nuclear Power Corp., Rutland). 4 Dec 1972. 1p. Dep. NTIS.

9033 (DOCKET-50280–98) SURRY POWER STATION, UNIT 1. Failure of Six Steam Generator Blowdown Isolation Valves to Close November 30, 1972. Containment Spray Pump Discovered Inoperable December 5, 1972. (Virginia Electric and Power Co., Richmond). 15 Dec 1972. 13p. Dep. NTIS.

9034 (DOCKET-50309–83) MAINE YANKEE ATOMIC POWER STATION. Inoperative High Pressure Safety Injection Pump. (Maine Yankee Atomic Power Co., Westboro, Mass.). 4 Dec 1972. 1p. Dep. NTIS.

9035 (DOCKET-50409–22) LA CROSSE BOILING WATER REACTOR. Incident Report Nos. DPC-72-13 and DPC-72-14. (Dairyland Power Cooperative, La Crosse, Wis.). 13 Nov 1972. 9p. Dep. NTIS.

Information is presented concerning an unscheduled reactor shutdown on November 2, 1972 and the failure of a control rod to insert at the normal scram speed. (D.C.C.)

9036 (DOCKET-50409–26) LA CROSSE BOILING WATER REACTOR. Technical Specifications, Change 9. (Directorate of Licensing (AEC), Washington, D. C.). 29 Nov 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the use of Core 2 fuel bundles. (D.C.C.)

9037 (DOCKET-50409–28) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report for September 1972. (Dairyland Power Cooperative, La Crosse, Wis.). 12 Dec 1972. Contract AT(11-1)-851. 26p. (DPC–851-48). Dep. NTIS.

9038 (DOCKET-50409–29) LA CROSSE BOILING WATER REACTOR. Steps Taken to Correct Item of Noncompliance Brought to Attention in Letter Dated August 11, 1972. (Dairyland Power Cooperative, La Crosse, Wis.). 18 Oct 1972. 6p. Dep. NTIS.

Information is presented concerning the operation of the forced circulation pump with leaks. (D.C.C.)

Safety and Siting

9039 (AEC-tr–7365) LONG TERM COMPUTER MODEL FOR DESCRIPTION OF THERMOHYDRAULIC PROCESSES IN THE PRIMARY LOOP OF A REACTOR DURING A LOSS-OF-COOLANT ACCIDENT. Kiesch, K. Translated by William J. Grimes from German report. 16p. Dep. NTIS.

Reprogramming of BRUCH D and BRUCH S codes from ALGOL to FORTRAN-4 is presented. These codes simulate hydrodynamic and thermodynamic relationships in the primary cooling systems of pressurized water and boiling water reactors respectively. (J.M.J.)

9040 (DOCKET-50010–123) DRESDEN NUCLEAR POWER STATION, UNIT 1. Steps Taken to Correct Items of Apparent Noncompliance Brought to Attention in Letter Dated October 19, 1972. (Commonwealth Edison Co., Chicago, Ill.). 21 Nov 1972. 10p. Dep. NTIS.

Additional information is presented concerning quality assurance requirements during construction of the reactor core spray system. (D.C.C.)

9041 (DOCKET-50016–176) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Technical Specifications, Change Request, December 4, 1972. (Power Reactor Development Co., Detroit, Mich.). 6 Dec 1972. 11p. Dep. NTIS.

Revised technical specifications are presented concerning the storage requirements for cut-up Core A fuel element subassemblies. (D.C.C.)

9042 (DOCKET-50016–177) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Technical Specifications, Change Request, Additional Information. (Power Reactor Development Co., Detroit, Mich.). 12 Dec 1972. 1p. Dep. NTIS.

Additional information is presented concerning revised technical specifications for the storage of cut-up fuel element subassemblies. (D.C.C.)

9043 (DOCKET-50016–178) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Technical Specifications, Revised Request for a Change. (Power Reactor Development Co., Detroit, Mich.). 15 Dec 1972. 11p. Dep. NTIS.

A request for revised technical specifications is presented concerning the storage requirements for cut-up Core A fuel subassemblies. (D.C.C.)

9044 (DOCKET-50029–218) YANKEE NUCLEAR POWER STATION. Inspection Discloses Mounting Bolts Missing. (Yankee Atomic Electric Co., Rowe, Mass.). 14 Dec 1972. 6p. Dep. NTIS.

9045 (DOCKET-50130–15) PATHFINDER GENERATING PLANT. Inspection, September 25–28, 1972. (Directorate of Regulatory Operations (AEC), Denver, Colo. Region IV). 17 Nov 1972. 15p. Dep. NTIS.

9046 (DOCKET-50133–101) HUMBOLDT BAY POWER PLANT, UNIT 3. Technical Specifications, Change 41. (Directorate of Licensing (AEC), Washington, D. C.). 6 Dec 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the operating requirements for the diesel-powered fire pump. (D.C.C.)

9047 (DOCKET-50155–131) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Change 33. (Directorate of Licensing (AEC), Washington, D. C.). 21 Nov 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning the testing of explosive actuated valves of the liquid poison system. (D.C.C.)

9048 (DOCKET-50155–132) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Change 34. (Directorate of Licensing (AEC), Washington, D. C.). 6 Dec 1972. 12p. Dep. NTIS.

Revised technical specifications are presented concerning the use of Reload G and NFS-DA fuel bundles. (D.C.C.)

9049 (DOCKET-50155–133) BIG ROCK POINT NUCLEAR PLANT. Modified F Fuel. (Consumers Power Co., Jackson, Mich.). 18 Dec 1972. 3p. Dep. NTIS.

9050 (DOCKET-50213–168) HADDAM NECK PLANT, UNIT 1. Emergency Core Cooling Performance for Loop Out of Service Operation. (Connecticut Yankee Atomic Power Co., Hartford). 5 Dec 1972. 12p. Dep. NTIS.

9051 (DOCKET-50213–169) HADDAM NECK PLANT, UNIT 1. Radwaste System Modifications. (Connecticut Yankee Atomic Power Co., Hartford). Nov 1972. 64p. Dep. NTIS.

9052 (DOCKET-50219–223) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Application for a Full Term License, Supplement 2. (Jersey Central Power and Light Co., Morristown, N. J.). 12 Dec 1972. 27p. Dep. NTIS.

Requested additional information is presented concerning the fuel cask handling system. (D.C.C.)

9053 (DOCKET-50244–131) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Technical Specifications, Change 7. (Directorate of Licensing (AEC), Washington, D. C.). 22 Nov 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning the values of quadrant power tilt limits. (D.C.C.)

9054 (DOCKET-50244–132) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Technical Specifications, Proposed Changes. (Rochester Gas and Electric Corp., N. Y.). 4 Dec 1972. 14p. Dep. NTIS.

Revised technical specifications are presented concerning plant reporting requirements. (D.C.C.)

9055 (DOCKET-50244–133) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Action Taken to Correct Item of Noncompliance Brought to Attention Following Inspection of August 8–10, 1972. (Rochester Gas and Electric Corp., N. Y.). 16 Nov 1972. 7p. Dep. NTIS.

Additional information is presented concerning the operation of radiation monitoring equipment for liquid radioactive effluents. (D.C.C.)

9056 (DOCKET-50245–175) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Notice of Consideration of Conversion of Provisional Operating License to Full-Term Operating License; Notice of Opportunity for Hearing; Notice of Opportunity for Public Participation in AEC Licensing Procedure. (Directorate of Licensing (AEC), Washington, D. C.). 29 Nov 1972. 9p. Dep. NTIS.

9057 (DOCKET-50250–105) TURKEY POINT PLANT, UNITS 3 AND 4. Steps Taken to Correct Items of Noncompliance Brought to Attention in Letter of October 5, 1972. (Florida Power and Light Co.). 29 Nov 1972. 9p. (DOCKET-50251–85). Dep. NTIS.

Additional information is presented concerning noncompliance to reporting and testing requirements. (D.C.C.)

9058 (DOCKET-50250–106) TURKEY POINT PLANT, UNITS 3 AND 4. Technical Specifications, Change 2. (Directorate of Licensing (AEC), Washington, D. C.). 5 Dec 1972. 2p. (DOCKET-50251–86). Dep. NTIS.

9059 (DOCKET-50254–148) QUAD-CITIES STATION, UNIT 1. Vibration Testing. (Commonwealth Edison Co., Chicago, Ill.). 6 Dec 1972. 2p. Dep. NTIS.

9060 (DOCKET-50255–117) PALISADES PLANT. Special Report No. 5, Palisades Plant Modification, Radioactive Waste, Circulating Water, Detailed System Description. (Consumers Power Co., Jackson, Mich.). 1 Dec 1972. 72p. Dep. NTIS.

9061 (DOCKET-50255–119) PALISADES PLANT. Technical Specifications, Additional Information on October 12, 1972 Request for Change. (Consumers Power Co., Jackson, Mich.). 8 Dec 1972. 2p. Dep. NTIS.

Additional information is presented concerning the revised reactor operating pressure. (D.C.C.)

9062 (DOCKET-50261–132) H. B. ROBINSON UNIT 2. Technical Specifications, Request for Change of Quadrant Power Tilt Limits. (Carolina Power and Light Co., Raleigh, N. C.). 15 Dec 1972. 3p. Dep. NTIS.

9063 (DOCKET-50263–164) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Supplement 1, Change Request 3, Request for Additional Information. (Directorate of Licensing (AEC), Washington, D. C.). 21 Dec 1972. 3p. Dep. NTIS.

A request for additional information is presented concerning control rod drop accident analysis. (D.C.C.)

9064 (DOCKET-50266–91) POINT BEACH NUCLEAR PLANT, UNIT 1. Comments on Items of Apparent Noncompliance Brought to Attention in Letter Dated September 15, 1972. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 9 Nov 1972. 13p. (DOCKET-50301–76). Dep. NTIS.

Additional information is presented concerning noncompliance to test requirements and maintenance procedures. (D.C.C.)

9065 (DOCKET-50266–92) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. KEWAUNEE NUCLEAR POWER PLANT. Environmental Radiation Survey, Annual Report, July 1971–June 1972. (Wisconsin Dept. of Health and Social Services, Madison). 14 Nov 1972. 25p. (DOCKET-50301–77; DOCKET-50305–60). Dep. NTIS.

For Wisconsin Electric Power Co., Milwaukee.

9066 (DOCKET-50266–93) POINT BEACH NUCLEAR PLANT, UNIT 1. Reactor Coolant Pipe Weld Indications. (Wisconsin Electric Power Co., Milwaukee). 11 Dec 1972. 3p. Dep. NTIS.

9067 (DOCKET-50269–81) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 38. (Duke Power Co., Charlotte, N. C.). 13 Dec 1972. 189p. (DOCKET-50270–68; DOCKET-50287–60). Dep. NTIS.

Revised information is presented concerning limiting conditions for operation, testing program, and administrative controls of operations. (D.C.C.)

9068 (DOCKET-50269–83) OCONEE NUCLEAR STATION, UNIT 1. Safety Evaluation, Supplement 2. (Directorate of Licensing (AEC), Washington, D. C.). 19 Dec 1972. 11p. Dep. NTIS.

9069 (DOCKET-50271–122) VERMONT YANKEE NUCLEAR POWER STATION. Technical Specifications, Proposed Change 16. (Vermont Yankee Nuclear Power Corp., Rutland). 20 Dec 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning increased possession limits for uranium-235 in replacement fuel elements. (D.C.C.)

9070 (DOCKET-50271–123) VERMONT YANKEE NUCLEAR POWER STATION. Technical Specifications, Proposed Change 6. (Vermont Yankee Nuclear Power Corp., Rutland). 20 Dec 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning release rates for gaseous radioactive effluents. (D.C.C.)

9071 (DOCKET-50275–28) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 379p. (DOCKET-50323–26). Dep. NTIS.

The environmental effects of construction and operation of the Diablo Canyon Power Reactor Units 1 and 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

9072 (DOCKET-50277–69) PEACH BOTTOM ATOMIC POWER STATION, UNIT 2. Action Taken to Correct Items of Noncompliance Brought to Attention Following Inspection of August 15–17, 1972. (Philadelphia Electric Co., Pa.). 17 Nov 1972. 6p. Dep. NTIS.

Additional information is presented concerning the use of latest revision engineering drawings during construction. (D.C.C.)

9073 (DOCKET-50277–70) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Safety Evaluation, Supplement 1. (Directorate of Licensing (AEC), Washington, D. C.). 11 Dec 1972. 10p. (DOCKET-50278–69). Dep. NTIS.

9074 (DOCKET-50280–94) SURRY POWER STATION, UNIT 1. Technical Specifications, Change No. 3. (Directorate of Licensing (AEC), Washington, D. C.). 5 Dec 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning primary containment structure leak rate testing. (D.C.C.)

9075 (DOCKET-50280–95) SURRY POWER STATION, UNIT 1. Fuel Densification. (Virginia Electric and Power Co., Richmond). 8 Dec 1972. 124p. (WCAP–8013). Dep. NTIS.

9076 (DOCKET-50282–83) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Environmental Monitoring and Ecological Studies Program, 1971 Annual Report. (Northern States Power Co., Minneapolis, Minn.). Jul 1971. 527p. (DOCKET-50306–79). Dep. NTIS.

9077 (DOCKET-50285–78) FORT CALHOUN STATION, UNIT 1. Final Safety Analysis Report, Supplement 19. (Omaha Public Power District, Nebr.). Dec 1972. 25p. Dep. NTIS.

Additional information is presented concerning pressurization of fuel elements and containment structure tendon grease. (D.C.C.)

9078 (DOCKET-50289–80) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 250p. (DOCKET-50320–38). Dep. NTIS.

The environmental effects of construction and operation of the Three Mile Island Power Reactor Units 1 and 2 are examined. The

descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

9079 (DOCKET-50289–81) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Report on Containment Building Ring Girder Construction and Repair, Addendum 3. (Metropolitan Edison Co., Reading, Pa.). 22 Aug 1972. 8p. Dep. NTIS.

9080 (DOCKET-50293–107) PILGRIM NUCLEAR POWER STATION. Barksdale Pressure Switches. (Boston Edison Co., Mass.). 8 Dec 1972. 3p. Dep. NTIS.

9081 (DOCKET-50295–72) ZION STATION NUCLEAR POWER PLANT, UNIT 1. Steps Taken to Correct Item of Apparent Noncompliance Brought to Attention in Letter Dated September 20, 1972. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 12 Oct 1972. 6p. Dep. NTIS.

Additional information is presented concerning flushing procedures for Class 1 piping. (D.C.C.)

9082 (DOCKET-50295–74) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 339p. Dep. NTIS.

The environmental effects of construction and operation of the Zion Power Reactor Units 1 and 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

9083 (DOCKET-50295–75) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 24. (Commonwealth Edison Co., Chicago, Ill.). 5 Dec 1972. 116p. (DOCKET-50304–72). Dep. NTIS.

Additional information is presented concerning personnel, operating procedures, instrumentation, and safety analysis. (D.C.C.)

9084 (DOCKET-50296–64) BROWNS FERRY NUCLEAR POWER STATION, UNIT 3. Steps Taken to Correct Items of Nonconformance Brought to Attention in Letter Dated November 2, 1972. (Tennessee Valley Authority, Chattanooga). 1 Dec 1972. 6p. Dep. NTIS.

Information is presented concerning radiographic inspection procedures for the pressure vessel. (D.C.C.)

9085 (DOCKET-50298–60) COOPER NUCLEAR STATION. Final Safety Analysis Report, Amendment 15. (Nebraska Public Power District, Columbus). 4 Dec 1972. 141p. Dep. NTIS.

Revised and requested data are presented concerning the cooling system, safety analysis, operations aspects, power conversion system, radioactive waste disposal, electrical systems, instrumentation, engineered safeguards, and containment system. (D.C.C.)

9086 (DOCKET-50301–78) POINT BEACH NUCLEAR PLANT, UNIT 2. Fuel Densification. (Wisconsin Electric Power Co., Milwaukee). Dec 1972. 77p. Dep. NTIS.

9087 (DOCKET-50305–59) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 22. (Wisconsin Public Service Corp., Green Bay). 1 Dec 1972. 149p. Dep. NTIS.

Revised and requested data are presented concerning the reactor containment system, personnel, safety analysis, power conversion system, electrical system, and instrumentation. (D.C.C.)

9088 (DOCKET-50309–84) MAINE YANKEE ATOMIC POWER STATION. Revision of Submittal of November 6, 1972 on Possible Fuel Densification. (Maine Yankee Atomic Power Co., Westboro, Mass.). 12 Dec 1972. 53p. Dep. NTIS.

9089 (DOCKET-50312–60) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report, Amendment 18. (Sacramento Municipal Utility District, Calif.). 1 Dec 1972. 93p. Dep. NTIS.

Revised and requested data are presented concerning safety analysis, power conversion system, instrumentation, auxiliary systems, piping systems, electrical systems, and quality assurance program. (D.C.C.)

9090 (DOCKET-50315–92) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 34. (Indiana and Michigan Power Co., New York, Indiana and Michigan Electric Co., New York). Dec 1972. 97p. (DOCKET-50316–92). Dep. NTIS.

The emergency plan for the Donald C. Cook Power Reactor Units 1 and 2 is presented. (D.C.C.)

9091 (DOCKET-50317–73) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Action Taken to Correct Items of Noncompliance Brought to Attention Following Inspection on September 12–15, 1972. (Baltimore Gas and Electric Co., Md.). 15 Nov 1972. 8p. (DOCKET-50318–70). Dep. NTIS.

Information is presented concerning construction requirements and cleanliness of construction site. (D.C.C.)

9092 (DOCKET-50321–61) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Controlling Combustible Gas in Primary Containment. (Georgia Power Co., Atlanta). 4 Dec 1972. 4p. Dep. NTIS.

9093 (DOCKET-50324–61) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Design Report No. 4, Addendum B; Design Reports Nos. 9 and 10, Addendum A. (Carolina Power and Light Co., Raleigh, N. C.). 8 Nov 1972. 56p. (DOCKET-50325–62). Dep. NTIS.

Requested additional information is presented concerning earthquake stress analysis for reactor buildings. (D.C.C.)

9094 (DOCKET-50324–63) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Steps Taken to Correct Items of Noncompliance Brought to Attention in Letter Dated September 18, 1972. (Carolina Power and Light Co., Raleigh, N. C.). 17 Oct 1972. 6p. (DOCKET-50325–64). Dep. NTIS.

Additional information is presented concerning quality assurance procedures, electrical cable support and protection, residual heat removal pump performance, and test requirements for the high pressure coolant injection pump. (D.C.C.)

9095 (DOCKET-50324–64) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Steps Taken to Correct Item in Violation of AEC Requirements Brought to Attention in Letter of November 3, 1972. (Carolina Power and Light Co., Raleigh, N. C.). 22 Nov 1972. 10p. (DOCKET-50325–65). Dep. NTIS.

Additional information is presented concerning quality assurance requirements during construction. (D.C.C.)

9096 (DOCKET-50331–69) DUANE ARNOLD ENERGY CENTER. Environmental Report, Amendment 3. (Iowa Electric Light and Power Co., Cedar Rapids). Dec 1972. 13p. Dep. NTIS.

9097 (DOCKET-50331–70) DUANE ARNOLD ENERGY CENTER. Provisional Construction Permit No. CPPR-70, Amendment 1. (Directorate of Licensing (AEC), Washington, D. C.). 14 Dec 1972. 3p. Dep. NTIS.

9098 (DOCKET-50338–54) NORTH ANNA POWER STATION, UNITS 1, 2, 3, AND 4. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 298p. (DOCKET-50339–51; DOCKET-50404–30; DOCKET-50405–30). Dep. NTIS.

The environmental effects of construction and operation of the North Anna Power Reactor Units 1, 2, 3, and 4 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

9099 (DOCKET-50348–48) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Supplementary Information. (Alabama Power Co., Birmingham). 7 Dec 1972. 15p. (DOCKET-50364–40). Dep. NTIS.

Additional information is presented concerning the water storage pond spillway. (D.C.C.)

9100 (DOCKET-50352–31) LIMERICK GENERATING STATION, UNITS 1 AND 2. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 381p. (DOCKET-50353–31). Dep. NTIS.

The environmental effects of construction and operation of the Limerick Power Reactor Units 1 and 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and

water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

9101 (DOCKET-50368-36) ARKANSAS NUCLEAR ONE, UNIT 2. Construction Permit No. CPPR-89, Related Notice and Initial Decision. (Directorate of Licensing (AEC), Washington, D. C.). 6 Dec 1972. 64p. Dep. NTIS.

9102 (DOCKET-50369-32) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Use of Reactor Vessel in Manufacture with Combustion Engineering Company. (Duke Power Co., Charlotte, N. C.). 5 Dec 1972. 2p. (DOCKET-50370-32). Dep. NTIS.

9103 (DOCKET-50382-45) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 27. (Louisiana Power and Light Co., New Orleans). 4 Dec 1972. 57p. Dep. NTIS.

Additional information is presented concerning site geology and containment system. (D.C.C.)

9104 (DOCKET-50387-25) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Environmental Report, Construction Permit Stage, Revised July 1, 1972, Amendment 1. (Pennsylvania Power and Light Co., Allentown). 7 Dec 1972. 218p. (DOCKET-50388-25). Dep. NTIS.

Information on the Susquehanna Power Reactor Units 1 and 2 is presented concerning site biota, transmission lines, and reactor effluents. Effects of reactor operations on the environment are analyzed. (D.C.C.)

9105 (DOCKET-50387-26) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Applicant's Environmental Report, Amendment 2. (Pennsylvania Power and Light Co., Allentown). 8 Dec 1972. 7p. (DOCKET-50388-26). Dep. NTIS.

9106 (DOCKET-50390-31) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 19. (Tennessee Valley Authority, Chattanooga). 5 Dec 1972. 8p. (DOCKET-50391-31). Dep. NTIS.

Additional information is presented concerning stresses in containment structures and stack. (D.C.C.)

9107 (DOCKET-50395-34) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 19. (South Carolina Electric and Gas Co., Columbia). 8 Dec 1972. 84p. Dep. NTIS.

Revised and requested data are presented concerning containment systems, safety analysis, and earthquake stresses on containment structures. (D.C.C.)

9108 (DOCKET-50397-33) HANFORD NO. 2 NUCLEAR POWER PLANT. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 279p. Dep. NTIS.

The environmental effects of construction and operation of the Hanford Power Reactor Unit 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

9109 (DOCKET-50397-34) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 16. (Washington Public Power Supply System, Richland). 8 Dec 1972. 69p. Dep. NTIS.

Additional information is presented concerning the geology and seismology of the reactor site. (D.C.C.)

9110 (DOCKET-50397-35) HANFORD NO. 2 NUCLEAR POWER PLANT. Safety Evaluation, Supplement 1. (Directorate of Licensing (AEC), Washington, D. C.). 15 Dec 1972. 13p. Dep. NTIS.

911 (DOCKET-50400-32) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 20. (Carolina Power and Light Co., Raleigh, N. C.). 14 Dec 1972. 90p. (DOCKET-50401-32; DOCKET-50402-32; DOCKET-50403-32). Dep. NTIS.

Requested additional data are presented concerning the reactor site, safety analysis, quality assurance program, radioactive waste disposal system, power conversion system, auxiliary systems, and engineered safeguards. (D.C.C.)

9112 (DOCKET-50404-31) NORTH ANNA POWER STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 14. (Virginia Electric and Power Co., Richmond). 13 Dec 1972. 10p. (DOCKET-50405-31). Dep. NTIS.

Requested additional information is presented concerning the containment system. (D.C.C.)

9113 (DOCKET-50404-32) NORTH ANNA POWER STATION, UNITS 3 AND 4. Permit Requests for Installation of Service Water System. (Virginia Electric and Power Co., Richmond). 6 Jun 1972. 16p. (DOCKET-50405-32). Dep. NTIS.

9114 (DOCKET-50409-23) LA CROSSE BOILING WATER REACTOR. Steps Taken to Correct Items of Apparent Noncompliance Brought to Attention in Letter Dated August 31, 1972. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 9 Nov 1972. 8p. Dep. NTIS.

Additional information is presented concerning gaseous radioactive effluents from the reactor. (D.C.C.)

9115 (DOCKET-50409-27) LA CROSSE BOILING WATER REACTOR. Analysis of Possible Damage to Engineered Safeguards. (Dairyland Power Cooperative, La Crosse, Wis.). 7 Dec 1972. 2p. Dep. NTIS.

9116 (DOCKET-50409-30) LA CROSSE BOILING WATER REACTOR. Technical Specifications, Change 8. (Directorate of Licensing (AEC), Washington, D. C.). 1 Dec 1972. 5p. Dep. NTIS.

Revised technical specifications are presented concerning the containment structure leak testing schedule. (D.C.C.)

9117 (DOCKET-50410-17) NINE MILE POINT NUCLEAR STATION, UNIT 2. Environmental Report and Preliminary Safety Analysis Report, Clarification. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 13 Dec 1972. 2p. Dep. NTIS.

Additional information is presented concerning the stack for the turbine building ventilation exhaust and offgases. (D.C.C.)

9118 (DOCKET-50413-6) CATAWBA NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Duke Power Co., Charlotte, N. C.). 27 Nov 1972. 86p. (DOCKET-50414-6). Dep. NTIS.

Additional information is presented concerning engineered safeguards, containment systems, and environmental radiation monitoring program. (D.C.C.)

9119 (TRG-Report-2317) RELEASE OF FISSION PRODUCTS FROM AGR TYPE FUEL AT AROUND 1000°C. Hillary, J. J.; Taylor, J. C. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 15 May 1972. 16p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

The early stages of a postulated, though very unlikely, accident to an Advanced Gas Cooled Reactor were simulated using stainless steel clad solid UO_2 fuel pellets. Early work was carried out on small pins containing a few pellets irradiated for relatively short times and at high ratings in an MTR. Later work used full-length pins irradiated for longer times at moderate ratings in WAGR. The pins were caused to fail at temperatures in the range 900 to 1200°C in flowing CO_2/CO at atmospheric pressure, and the fission product release was measured. The experiments indicated that release of ^{131}I was lower than that of ^{133}Xe particularly at higher releases of ^{133}Xe. Most of the released iodine was deposited close to the high temperature zone and only a small proportion was in a penetrating form. The release of ^{137}Cs was similar to that of ^{131}I. No other fission products were found in measurable amounts, excepting the long-lived and stable inert gases ^{85}Kr and ^{134}Xe, the releases of which, measured on full length pins, were very similar and more than an order of magnitude greater than the ^{133}Xe release. The release of ^{134}Xe from the small pins was similar to that of the ^{133}Xe. The results, expressed as inert gas/^{131}I release ratio, may be used for estimating ^{131}I release where inert gas release is calculable. (auth)

9120 (WASH-1227(Vol.2)) FAST FLUX TEST FACILITY. Preliminary Safety Analysis Report. (WADCO Corp., Richland, Wash.). Sep 1970. Contract AT(45-1)-2170. 389p. Dep. NTIS.

Information on the Fast Flux Test Facility is presented under the following headings: auxiliary systems; radioactive waste disposal system; shielding; operations; testing; safety analysis; quality assurance program; design characteristics; and containment system tests. (D.C.C.)

9121 INTERACTION OF SOIL AND POWER PLANTS IN EARTHQUAKES. Isenberg, J.; Adham, S. A. (Agbabian Associates, Los Angeles). J. Power Div., Amer. Soc. Civil Eng.; 98: No. PO2, 273-91(Oct 1972).

Bedrock motions are generated from a segment of the Golden Gate record and are applied to a four-layer elastic finite element of a soil site. Three different finite-element models are derived to represent a nuclear reactor structure, each reflecting a different degree of refinement. The least refined is a one-dimensional model, having lumped masses, which is rigidly connected to the soil and is subjected to motions found at 45-ft depth in the free field. A second model is identical to the first except that springs are interposed between the base of the one-dimensional model and the soil in order to represent translational and rotational modes of interaction. The most refined of the present models is a two-dimensional dynamic elastic finite-element representation of the soil embedded foundation and walls and containment and support structures. The results of the various analyses are compared and conclusions are drawn regarding the necessity to include refined model of soil/structure interaction in seismic analyses. 18 references. (auth)

9122 CITIZENS V. ATOMIC POWER. Lewis, R. New Sci.; 56: No. 821, 450-2(23 Nov 1972).

It is stated that the growth of nuclear power has slowed down recently due to the rising concern over environmental pollution. This concern has been expressed by the persistent and frequently effective intervention of citizen groups and environmental organizations in the AEC'S reactor licensing process. There the intervenors have been challenging the Commission's safety, radiological, and thermal pollution standards, with the result that the AEC has been impelled to tighten up its regulatory policy. (auth)

Steam and Power Conversion Systems

9123 (LIB/Trans-455) EVALUATION OF THE COST OF COOLING STEAM TURBINES. Hauser, L. G. Translated by A. P. Marks (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Energ. Nucl. (Paris); 13: No. 6, 444-6(1971). 10p. Dep. NTIS (U. S. Sales Only).

A comparison is made between the cost of cooling fossil fuel power plants and nuclear fuel power plants. The economics of the choice of cooling water feed system and site are studied. (France)

9124 CIRCULATING WATER SYSTEMS WITHOUT VALVES. Wahanik, R. J. (Gilbert Associates, Inc., Reading, Pa.). J. Power Div., Amer. Soc. Civil Eng.; 98: No. PO2, 187-99(Oct 1972).

An analysis of the performance and operational problems of a circulating-water cooling system was made for a large nuclear thermo-generating plant (Crystal River-3), where one pump serves a conduit and a surface condenser. The analysis covers: (1) The effect that the dissolved air of the intake water has on the time required to prime the system; (2) hydraulic transients that occur in a primed system after starting a circulating water pump with falling power characteristics; (3) influence of vacuum breaker operation on the hydraulic transients occuring in the system after pump tripout; and (4) additional equipment needed for successful operation of the system. (auth)

9125 POWER PLANT COOLING SYSTEMS. Kinsman, George (Florida Power and Light Co., Miami). J. Power Div., Amer. Soc. Civil Eng.; 98: No. PO2, 247-52(Oct 1972).

Given are types of systems now available and proposed with data required from other than engineering sources to insure compliance with environmental regulations covering both nuclear and fossil-fueled plants. Large quantities of heat for steam condensation must be dissipated to the atmosphere, requiring considerable quantities of water. Volume of water available, its temperature and quality, meteorological conditions, economics and environmental consequences must be considered in the selection of cooling system. Once-through and closed system wet and dry cooling towers, forced and natural draft types using fresh or salt water are available. Environmental regulations require input from many nonengineering disciplines. (auth)

Propulsion and Auxiliary Power Reactors

9126 (LA-5057) NUCLEAR ROCKET REFERENCE DATA SUMMARY. Balcomb, J. D. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 13p. Dep. NTIS.

A brief description of the design and operating characteristics of a nuclear rocket engine is presented. The engine has a mass of ~2550 kg and is designed to operate at a specific impulse of 875 s for one hour at a thrust of 73,000 N or at a specific impulse of 860 s for two hours at a thrust of 71,700 N. The startup, shutdown, and cooldown performance characteristics are described. Operating characteristics special to a nuclear engine are summarized including radiation environment, nuclear criticality safety, prestart conditioning, and postrun deadbands. The technology status and proposed development schedule of the engine are discussed. The growth potential of the engine to a 975-s specific-impulse version incorporating carbide fuel elements is presented, and the potential of the reactor to double as a heat source for a long-term 10-kW electrical power supply is discussed. (auth)

9127 (TID-26229) DEVELOPMENT OF A MODEL AND TEST EQUIPMENT FOR COLD-FLOW TESTS AT 500 ATM OF SMALL NUCLEAR LIGHT BULB CONFIGURATIONS. Jaminet, J. F. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1972. 27p. (L-910900-14). Dep. NTIS.

A model and test equipment were developed and cold-flow-tested at greater than 500 atm in preparation for future high-pressure rf plasma experiments and in-reactor tests with small nuclear light bulb configurations. With minor exceptions, the model chamber is similar in design and dimensions to a proposed in-reactor geometry for tests with fissioning uranium plasmas in the Nuclear Furnace. The model and the equipment were designed for use with the UARL 1.2-MW rf induction heater in tests with rf plasmas at pressures up to 500 atm. The model consists of (1) a 6.6-cm-diam, 17.8-cm-long vortex chamber formed by a fused silica tube with water-cooled copper and stainless-steel end walls, (2) a fiberglass filament-wound pressure vessel around the fused silica tube, and (3) a pair of stainless-steel split retainer flanges which transmit the axial pressure load from the end walls to the pressure vessel. Initially, tests were conducted to verify the strength and reliability of the filament-wound pressure vessel design. One vessel was hydrostatically tested to 680 atm before it failed. Another was cycled more than 60 times between 0 and at least 545 atm before it developed a crack in the outer fiber layers. A series of cold-flow tests of the model was then conducted at pressures up to about 510 atm. At 504 atm, the flow rates of argon and cooling water were 3.35 liter/sec (STP) and 26 gal/min, respectively. It was demonstrated that the model is capable of being operated for extended periods at the 500-atm pressure level and is, therefore, ready for use in initial high-pressure rf plasma experiments. 9 references. (auth)

Research and Test Reactors

Refer also to abstract 7870.

9128 (BNWL-1674) PLUTONIUM RECYCLE BURNUP DATA AND RESULTS FROM THE BATCH CORE EXPERIMENT. Christensen, D. E.; Kottwitz, D. A.; Oden, D. R.; Matsen, R. P. (Battelle Pacific Northwest Labs., Richland, Wash.). Jul 1972. Contract AT(45-1)-1830. 159p. Dep. NTIS.

As a result of the Batch Core Experiment which was conducted in the Plutonium Recycle Test Reactor, a large amount of burnup data and gamma-ray data was made available for analysis. The data represented plutonium recycle fuel in that the fuel composition was initially UO_2-2 wt% PuO_2. A maximum burnup of 9485 MWD/MTM was determined from the fuel samples analyzed. The burnup data were then used to derive effective cross section ratios utilizing a least-squares fitting code. The results indicate exposure averaged values of 0.2240 ± 0.0009 and 0.5159 ± 0.0106 for, respectively, the capture to fission ratio of ^{235}U and ^{239}Pu for the mixed oxide fuel. The gamma-ray data were analyzed to determine power distributions and effects of fission product migration. The results indicated localized regions of fission product concentrations due to the migrations of ^{106}Ru, ^{106}Rh, ^{134}Cs and ^{137}Cs. 26 references. (auth)

9129 (WASH-1227(Vol.1)) FAST FLUX TEST FACILITY. Preliminary Safety Analysis Report. (WADCO Corp., Richland, Wash.). Sep 1970. Contract AT(45-1)-2170. 15p. Dep. NTIS.

Information on the Fast Flux Test Facility is presented under the following headings: reactor site; design characteristics; cooling system; containment structure; engineered safeguards; instrumentation and control system; electrical systems; irradiation testing facilities; and fuel handling system. (D.C.C.)

9130 DEVELOPMENT OF NUCLEAR REACTOR CORES FOR ENERGY PRODUCTION: A TOOL FOR EXPERIMENTAL STUDIES. Naigeon, Jacques (Groupement Atomique Alsacienne Atlantique, Le Plessis-Robinson, France). Rev. Fr. Energ.; 23: No. 245, 565-72(Sep 1972). (In French).

Critical split-table assemblies are excellent tools for studying

the physics of the cores of power reactors. The assembly developed by the GAAA (Groupement Atomique Alsacienne Atlantique) for Australia is described and the various research possibilities offered are discussed. (France)

9131 RESEARCH WITH NEUTRONS. Evora, Jean. Sci. Avenir; No. 308, 834-7(Oct 1972). (In French).

The high flux reactor at Grenoble is to be used to study living and inert matter and to investigate the mechanisms concerned with the living process. Neutrons of three different characteristic spectra are produced. (France)

9132 TURBULENT FLOW PRESSURE DROP MODEL FOR FUEL ROD ASSEMBLIES UTILIZING A HELICAL WIRE-WRAP SPACER SYSTEM. Novendstern, E. H. (Westinghouse Electric Corp., Madison, PA). Nucl. Eng. Des.; 22: No. 1, 19-27(1972).

A semi-empirical model is developed that can accurately predict pressure losses in a hexagonal array of fuel pins utilizing a wire-wrap spacer system. The model is able to predict pressure drop to within ±14% over a wide range of geometries in the turbulent flow regime. The model compares favorably with independent pressure drop measurements, not used to obtain the correlation, made on a FFTF 217-pin fuel pin bundle with 400 to 1100°F flowing sodium. A numerical example is presented using the new model. 13 references. (auth)

9133 INHOMOGENOUS URANIUM DISTRIBUTION IN THE PLATES OF THE HFR GRENOBLE. COMPUTER STUDIES ABOUT POSSIBLE EFFECTS ON THE OPERATIONAL BEHAVIOR. Ihle, P.; Malang, S.; Politzky, H. M.; Rust, K. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 12, 623-4(Dec 1972). (In German).

During examination of the plates for the first fuel element of the HFR Grenoble, inhomogeneities in distribution of the fissionable material were found. The unequal distribution could possibly lead to localized boiling of the cooling medium, to an intolerable high rate of corrosion, and to a deformation of the fuel plates. With the computer program RELAX, the 3-dimensional temperature field was computed for three cases. Results showed that, in spite of the inhomogeneities, the reactor could be operated without any danger at the designed power. (tr-auth)

Production Reactors

9134 (DUN-3130) RECOMMENDED SEISMIC DESIGN CRITERIA FOR HANFORD NUCLEAR FACILITY. Housner, G. W. (Douglas United Nuclear, Inc., Richland, Wash.). 1 Oct 1972. Contract AT(45-1)-1857. 27p. Dep. NTIS.

The Hanford nuclear facility, located in south-central Washington State, consists of a number of reactors and their appurtenances. The reactors are in separate reinforced concrete buildings which may be described as typical good quality eastern United States public utility construction. Recommendations are made for the seismic safety of the Hanford facility based on detailed information on the seismic history and the geology of the region. Seismic design criteria for the reactor core are not included. (L.C.L.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 7834, 7836, 7843, 7886, and 7935.

9135 (RDT-C-17-8-T) ANNUNCIATORS FOR CONTROL SYSTEMS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1972. 17p. RSO.

The basic requirements for design, manufacture, quality assurance, preparation for delivery and shipping of general-purpose single and multiple-point annunciators for use in plant operation systems (control systems) of nuclear reactors and other test facilities are presented. The annunciator includes that equipment required to monitor the input signals supplied to it, to recognize the normal or abnormal condition of each signal, and to provide visual and audible outputs of the results in an appropriate manner. (auth)

9136 SPACER DEVICE FOR A HEAT EXCHANGE ARRAY PRINCIPALLY FOR NUCLEAR FUEL ASSEMBLIES. Skok, Jean (to Commissariat a l'Energie Atomique). French Patent 2,111,642. 9 Jun 1972. Filed 13 Oct 1970. (In French).

The invention concerns heat exchange arrays in the form of tubes in an envelope, nuclear fuel assemblies with a parallel array of pins in an envelope acting as a duct for the circulation of a coolant fluid (the cladding of the pins serving as the tubes) being of particular interest. A spacer device for maintaining the tubes or pins transverse to one another and also to the assembly envelope is described. The device consists of an array of plates positioned obliquely in relation to the aligned elements. These plates are provided with holes in which the elements are held by a light friction fit, spaces existing through which a heat exchange fluid can flow in a direction parallel to the elements. The plates press against the envelope containing the array and guide the heat exchange fluid. (France)

9137 INSTALLATION FOR WORKING IN A TUBULAR EXCHANGER. Peyrot, J. P.; Thome, P. (to Societe Techniques Nouvelles Appliquees). French Patent 2,112,014. 16 Jun 1972. Filed 22 May 1970. (In French).

An installation for working in a tubular array heat exchanger is described. It consists of a machine for working inside the exchanger, a means of introducing it into the exchanger, and positioning it in relation to a fixed marker in the exchanger, and a means of bringing it up to a predetermined tube by advancing it step by step while simultaneously noting the number of tubes separating the tube of interest from the marker. The exchanger is provided with a vertical column without tubes which facilitates the introduction of the machine into an accessible part of the exchanger and its positioning beyond the far end of the array (the working region). (France)

9138 SUMMARY OF EXPERIMENTAL INVESTIGATIONS ON THE WEDGE WINDING METHOD FOR PRESTRESSING CYLINDRICAL CONCRETE PRESSURE VESSEL STRUCTURES. Hiraga, K.; Takemori, T.; Terada, K.; (and others) (Taisei Construction Co., Ltd., Tokyo). Nucl. Eng. Des.; 22: No. 1, 124-37(1972).

The idea of using prestressed concrete for large pressure vessels or containments has been widely adopted in reactor systems all over the world. In order to improve the method of circumferential prestressing of cylindrical concrete structures, Taisei Construction Company developed a new construction method which is named the wedge winding method. This method has been verified as being very effective and fully practical through the experiment described. The distinguishing feature of this method is that no special, heavy machines and devices are required, and prestressing compression in cylindrical concrete structures can easily be provided by ordinary hydraulic jacks. (auth)

9139 APPROXIMATE ANALYSIS OF STRUCTURES COMPOSED OF NON-HOMOGENEOUS LINEAR VISCO-ELASTIC MATERIAL. Goodall, I. W.; Irving, J. (Berkeley Nuclear Labs., Eng.). Nucl. Eng. Des.; 22: No. 1, 63-74(1972).

A general method of analysis is presented for structures composed of non-homogeneous linear visco-elastic material and subjected to applied loads and displacements which are step functions of time. The procedure establishes the elastic and stationary-state response exactly and also furnishes a good approximation to the transient response. An application of the procedure to a problem of practical interest from the pressure vessel field is included. 9 references. (auth)

9140 CONSIDERATION OF RADIATION BRITTLING IN THE DESIGN OF REACTOR PRESSURE VESSELS. Leitz, C. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech.; 17: No. 12, 614-19(Dec 1972). (In German).

For the design of reactor pressure vessels, radiation-induced embrittlement is determined by a shift in the Nil Ductility Transition Temperature (ΔNDT). Evaluation of recently published radiation data shows that the previous design curves of the Δ NDT-fluence diagram can be abandoned and lower ones applied; however, certain limitations must then be maintained with respect to steel additions in the pressure vessel (basic as well as welding materials). These limitations are as follows: maximal contents of 0.10% Cu; 0.012% P; and 0.05% V. Additional inclusions that must be taken into consideration are discussed. 40 references. (tr-auth)

Reactor Physics and Core Engineering

Physics

9141 CRITICALITY OF GRAPHITE- AND POLYETHYLENE-REFLECTED URANIUM (93.2 PERCENT)-METAL CYLINDERS AND ANNULI. Mihalczo, J. T. (Union Carbide Corp., Oak Ridge, TN). Nucl. Sci. Eng.; 49: No. 4, 489-504(Dec 1972).

Cylinders and cylindrical annuli of uranium metal (93.15 wt % ^{235}U), with diameters varying from 7 to 15 in., were assembled to delayed criticality with graphite reflectors varying in thickness up to 18 in. or with ai 'fectively infinite thickness polyethylene on all outer surfaces. In one series of measurements a polyethylene reflector was also placed adjacent to only one flat surface of the cylinders. The multiplication factor calculated by both S_n transport and Monte Carlo methods, with various sets of cross sections agreed very well with the experimental values. As a result of the high order of S_n and the large number of spatial intervals required, the computing time for the transport theory calculations was a factor of 10 larger than that required for the Monte Carlo calculations with standard deviations of 1%. (auth)

Core Thermal Hydraulics

9142 SUBCHANNEL FLOW AND ENTHALPY DISTRIBUTIONS AT THE EXIT OF A TYPICAL NUCLEAR FUEL CORE GEOMETRY. Castellana, F. S.; Casterline, J. E. (Columbia Univ., New York). Nucl. Eng. Des.; 22: No. 1, 3-18(1972).

Simultaneous measurements of flow and enthalpy were made at the exits of two subchannels in a sixteen rod electrically heated full-scale model of a typical LWR fuel rod geometry. Experimental data were obtained for conditions of both subcooled and bulk boiling, and were compared to predictions by the COBRA-II subchannel computer analysis to assess the applicability of the code, and to approximately determine the extent of cross channel turbulent mixing. 20 references. (auth)

GENERAL

Civilian Defense

9143 (ORNL-TM-3552(Pt.1)) PROGRAM TO COUNTER THE EFFECTS OF NUCLEAR ELECTROMAGNETIC PULSE IN COMMERCIAL POWER SYSTEMS. Nelson, D. B. (Oak Ridge National Lab., Tenn.). Oct 1972. 38p. Dep. NTIS.

An assessment of the possible effects on commercial electric power systems from the electromagnetic pulse (EMP) produced by high altitude nuclear detonations is provided. Included are discussions of EMP coupling and control cables, and comparisons with direct lightning strokes and voltage surges produced by the switching of power lines under load. The type and probability of damage or malfunction from EMP effects, its significance during and after a nuclear attack, and countermeasures to reduce disruption and to harden electric power systems are considered. It is concluded that the major effects from EMP on widespread power failure on a national scale will be at the very beginning of a nuclear attack. Present design trends may result in future power systems which are more susceptible to damage than present systems. Methods are available to greatly reduce the vulnerability of power system components, but testing is required to determine whether these can be applied economically. (262 references.) (auth)

Management

9144 EMERGING ROLE OF THE CAMPUS RADIATION-SAFETY OFFICER. Ziemer, P. L. (Purdue Univ., Lafayette, Ind.). Nucl. Safety; 13: No. 6, 482-9(1972).

University radiation-safety officers (RSOs) from throughout the United States and Canada met at Purdue University in September 1971 to examine their role on the campus and how this role is changing. The conference focused primarily on administrative aspects of campus radiation-safety programs but also included discussions of practical health-physics problems common to the campuses. A wide diversity was seen in the organizational structures and responsibilities of the many universities represented. The campus RSO participates in health-physics administration, teaching, and research. Finding the proper balance of these functions in an organizationally sound framework will permit him to fill his role in meeting the growing health-physics needs of his campus in the future. (auth)

Miscellaneous

9145 (AAEC/E-235) AAEC MODIFICATIONS AND ADDITIONS TO THE IBM 360 OPERATING SYSTEM. Angus, W. A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jun 1972. 120p. Dep. NTIS (U. S. Sales Only).

9146 (ABCC-TR-3-72) TWO INSTANCES OF LEUKEMIA IN SIBLINGS. Okada, H.; Ishimaru, T. (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 20 Jan 1972. 13p. (In Japanese and English). Dep. NTIS.

9147 (ABCC-TR-18-72) POSTMORTEM HEPATITIS ASSOCIATED ANTIGEN IN BLOOD AND LIVER HISTOLOGY AMONG JAPANESE. McGregor, D. H.; Belsky, J. L.; Ishimaru, T.; King, R. A. (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 1 Jul 1972. 10p. (In Japanese and English). Dep. NTIS.

9148 (ABCC-TR-19-71) SERUM PEPSIN AND TUBELESS GASTRIC ANALYSIS AS PREDICTORS OF STOMACH CANCER. A 10-YEAR FOLLOW-UP STUDY, HIROSHIMA. Pastore, J. O.; Kato, H.; Belsky, J. L. (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 1 Jul 1971. 27p. (In Japanese and English). Dep. NTIS.

9149 (AEC-tr-7377) APPLICABILITY OF PERTURBATION THEORY IN DESCRIBING THE PROCESS OF MULTIPHOTON IONIZATION OF AN ATOM. Delone, G. A.; Delone, N. B.; Manakov, N. L.; Piskova, G. K. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated from report NP-19126. 8p. Dep. NTIS.

9150 (AEEW-R-500) NEW CORRELATION OF NON-UNIFORMLY HEATED ROUND TUBE BURNOUT DATA. Kirby, G. J. (Atomic Energy Establishment, Winfrith (England)). Jul 1966. 49p. Dep. NTIS (U. S. Sales Only). UK 7s.

9151 (BDX-613-261(Rev)) TYPIST'S GUIDE TO BENDIX KANSAS CITY TECHNICAL REPORTS. Walker, F. A. (Bendix Corp., Kansas City, Mo.). Nov 1972. Contract AT(29-1)-613. 79p. Dep. NTIS.

9152 (BDX-613-613(Rev.)) ELECTRICAL TERMINATIONS: WELDED, BRAZED, AND BONDED, FY72-2. Quarterly Report. Stittsworth, D. E. (Bendix Corp., Kansas City, Mo.). Dec 1972. Contract AT(29-1)-613. 43p. Dep. NTIS.

9153 (BDX-613-812) TESTING FOR MATERIAL FLAWS AND THERMAL DESIGN DEFECTS USING HOLOGRAPHIC INTERFEROMETRY. Collins, M. C.; Schoeppner, M. P.; Watterson, C. E. (Bendix Corp., Kansas City, Mo.). Dec 1972. Contract AT(29-1)-613. 27p. Dep. NTIS.

9154 (BNL-tr-512) STUDY OF THE RADIATION PRODUCED BY A MOVING CHARGE IN A PLATE AND IN A STACK OF PLATES BY USING KNOWN AND MORE SIMPLE FIELDS. Arakelyan, V. A.; Garibyan, G. M. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 339-51(1969). 18p. Dep. NTIS.

9155 (CALT-767-P-3-25) TECHNIQUE FOR BERG-BARRETT STEREO TOPOGRAPHY. Tu, L. K.; Vreeland, T. Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). [nd]. 5p. Dep. NTIS.

9156 (CALT-767-P-3-28) DISLOCATION INTERACTIONS WITH THERMAL PHONONS AND CONDUCTION ELECTRONS. Vreeland, T. Jr.; Jassby, K. M. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). 1972. 24p. Dep. NTIS.

9157 (CALT-822-46) APPLICATION OF THE OSTWALD'S RULE TO AMORPHOUS MATERIALS. Anseau, M. R. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Oct 1972. Contract AT(04-3)-822. 9p. Dep. NTIS.

9158 (LA-5022) RESPIRATOR-CARTRIDGE FILTER EFFICIENCY UNDER CYCLIC AND STEADY-FLOW CONDITIONS. Stafford, R. G.; Ettinger, H. J.; Rowland, T. J. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 13p. Dep. NTIS.

9159 (CEA-CONF-2056) GRAPHITE CONE CALORIMETERS FOR LASERS. Boutineau, J. L.; Sauneuf, R. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 1964. 8p. (In French). (CONF-720573-1). Dep. NTIS (U. S. Sales Only).

From fourth national meeting on calorimetry and differential thermal analysis; Paris, France (4 May 1972).

9160 (CEA-CONF-2060) SPECTROMETRIC ANALYSIS OF NONCONDUCTORS BY MEANS OF A LUMINESCENT DISCHARGE. Ropert, M.-E.; Drevon, H. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 4p. (In French). (CONF-720660-1). Dep. NTIS (U. S. Sales Only).

From 31st congress of the group for the advancement of physical methods of analysis; Paris, France (5 Jun 1972).

9161 (CEA-CONF-2081) TWO NEW DEVICES FOR ELECTROSTATES PRECIPITATION OF AEROSOLS. 1. MASS SAMPLER. 2. GRANULOMETRIC SEPARATION. Volsy, Robert (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 9p. (In French). (CONF-720576-1). Dep. NTIS (U. S. Sales Only).

From 1972 conference on the polluted atmosphere; Paris, France (3 May 1972).

9162 (CEA-R-4331) SPURIOUS REFLECTIONS IN AN OPTICAL SYSTEM. Gallais, G. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Jul 1972. 77p. (In French). Dep. NTIS (U. S. Sales Only).

9163 (CEA-R-4359) BEHAVIOR OF CHLOROQUINE (A SYNTHESIZED ANTI-MALARIA DRUG) LABELED WITH ^{14}C IN HEALTHY AND MALARIOUS ANIMALS. Coulibaly, Kafana (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1972. 178p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France).

9164 (CEA-R-4369) NUMERICAL SOLUTION OF FICK'S EQUATION FOR A CONCENTRATION DEPENDENT CHEMICAL

DIFFUSION COEFFICIENT (DETERMINATION OF CHEMICAL DIFFUSION COEFFICIENTS FROM CONCENTRATION DISTANCE CURVES AND CONVERSELY; CASE OF INFINITE MEDIA). Cornet, Jean-Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1972. 19p. (In French). Dep. NTIS (U. S. Sales Only).

9165 (CERN-Trans-72-10) METHOD OF MEASURING PHASE DIFFERENCES WITH A DOUBLE FREQUENCY TRANSFORMATION. Vishnevskaya, A. M.; Prosin, B. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by B. Hodge (CERN, Geneva), from report IFVE-OP-70-36. 8p. Dep. NTIS (U. S. Sales Only).

9166 (CONF-720944-1) SOME COMMENTS ON METHODS AND ETHICS OF ACCESS. Taeuber, R. C. (Oak Ridge National Lab., Tenn.). [nd]. 19p. Dep. NTIS.
From Conference on the current population survey; University Park, PA. (21 Sep 1972).

9167 (COO-1473-11) ECOLOGICAL INVESTIGATIONS OF ICE WORMS ON CASEMENT GLACIER, SOUTHEASTERN ALASKA. Institute of Polar Studies Report No. 39. Goodman, Daniel (Ohio State Univ. Research Foundation, Columbus). Dec 1971. Contract AT(11-1)-1473. 64p. Dep. NTIS.

9168 (COO-2048-8) [PLASTIC INSTABILITY IN PURE SHEAR]. Annual Report, Part III. Chakrabarti, A. K.; Dalder, E. N. C.; Hauser, D.; McGarry, D. L.; Russo, V. J.; Spretnak, J. W. (Ohio State Univ. Research Foundation, Columbus). Sep 1972. Contract AT(11-1)-2048. 28p. Dep. NTIS.

9169 (COO-2059-16) NUMERICAL SIMULATION OF A ONE-DIMENSIONAL KINETIC SYSTEM IN EQUILIBRIUM. Williams, J. H. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Dec 1972. Contract AT(11-1)-2059. 95p. Dep. NTIS.
Thesis.

9170 (COO-2153-1) COMPARISON OF TROPICAL SYNOPTIC-SCALE WIND SPECTRA AND SEASONAL PARAMETERS. Technical Progress Report No. 1. Dartt, D. G.; Hovland, D. N.; Belmont, A. D. (Control Data Corp., Minneapolis, Minn. Meteorology Research Dept.). 1 Mar 1972. Contract AT(11-1)-2153. 20p. Dep. NTIS.

9171 (COO-2183-2) NUCLEATION OF VOIDS. Annual Progress Report. Katz, Joseph L. (Clarkson Coll. of Tech., Potsdam, N. Y. Dept. of Chemical Engineering). 1972. Contract AT(11-1)-2183. 3p. Dep. NTIS.

9172 (COO-2203-1) CRITICAL SCATTERING OF LASER LIGHT BY THIN FLUID FILMS. Progress Report. Mockler, Richard; O'Sullivan, William (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). 1972. Contract AT(11-1)-2203. 21p. Dep. NTIS.

9173 (COO-3087-2) FURTHER EVIDENCE FOR POST-TRANSCRIPTIONAL CONTROL OF INDUCIBLE TYROSINE AMINOTRANSFERASE SYNTHESIS IN CULTURED HEPATOMA CELLS. Tomkins, G. M.; Levinson, B. B.; Baxter, J. D.; Dethlefsen, Lyle (Utah Univ., Salt Lake City (USA). Dept. of Radiology). 1972. Contract AT(11-1)-3087. 25p. Dep. NTIS.

9174 (COO-3133-1) USE OF MOLECULAR HYBRIDIZATION WITH RIBOSOMAL RNA TO EXPLORE DISTANT GENETIC RELATIONSHIPS. Progress Report, November 1, 1971–October 30, 1972. Atwood, K. C. (Columbia Univ., New York. Dept. of Human Genetics and Development). [nd]. Contract AT(11-1)-3133. 5p. Dep. NTIS.

Heterologous rRNA-DNA hybridizations and competition experiments indicated that homology among distantly related eukaryotes is not the residual of random divergence, but resides in special conserved sequences. In situ hybridization of rRNA to human metaphase plates mapped the rDNA in the five satellited chromosomes. Similar studies in the mouse indicated that no more than two pairs are involved. An efficient screening system was constructed in Drosophila for detecting x-ray induced reactivation of inactive rDNA. In E. coli the number of large rRNA genes in certain episomes did not equal the number of 5S RNA genes, showing that the 5S RNA genes do not occupy the same transcriptional units as those for 16S and 23S rRNA. (auth)

9175 (COO-3151-9) SOME SIZE EFFECTS IN METALS IN THE FAR INFRARED. Tanner, D. B. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Aug 1972. Contract AT(11-1)-3151. 169p. Dep. NTIS.
Thesis.

9176 (COO-3151-12) HYDROSTATIC PRESSURE STUDIES OF MAGNETIC MODES IN THE FAR INFRARED. Johnson, K. C. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Aug 1972. Contract AT(11-1)-3151. 147p. Dep. NTIS.
Thesis.

9177 (COO-3171-11) DEFECT ENERGETICS FOR SELF-DIFFUSION IN SODIUM. Ho, P. S. (Cornell Univ., Ithaca, N. Y. Argonne National Lab., Ill.). Jul 1972. Contract AT-(11-1)-3171. 29p. Dep. NTIS.

9178 (COO-3222-2) NITROGEN METABOLISM IN THE SEA. Technical Progress Report for the Period November 1, 1971–October 31, 1972. (Columbia Univ., Palisades, N. Y. Lamont-Doherty Geological Observatory). 31 Oct 1972. Contract AT(11-1)-3222. 248p. Dep. NTIS.

9179 (COO-3474-1) CYCLING AND EFFECTS OF ^{36}Cl LABELED DDT ON SOIL INVERTEBRATES. Annual Progress Report. Dindal, D. L. (State Univ. of New York, Syracuse (USA). Coll. of Environmental Science and Forestry). [nd]. Contract AT(11-1)-3474. 30p. Dep. NTIS.

9180 (EIR-221) USE OF A POWER SERIES OR OF THEIR CONTINUED FRACTIONS FOR THE NUMERICAL CALCULATION OF ANALYTICAL FUNCTIONS. Patry, J. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Aug 1972. 31p. (In French). Dep. NTIS (U. S. Sales Only).

9181 (EUR-4869) PROGRAM FOR THE THEORETICAL RECONSTRUCTION OF ESR SPECTRA. Mongini, L.; Thonet, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct 1972. 30p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 40.-.

9182 (INP-804) ELECTRIC FIELD GRADIENTS AT ^{57}Fe IN hcp METALS. Sawicki, J. A. (Institute of Nuclear Physics, Krakow (Poland)). Jun 1972. 9p. Dep. NTIS (U. S. Sales Only).

9183 (ITF-72-1-P) RESEARCH OF GROUP DECOMPOSING FOR BINARY DISTRIBUTION FUNCTIONS OF PARTICLES SYSTEMS WITH ELECTROSTATIC INTERACTION. I. THE THIRD VIRIAL COEFFICIENT. Yukhnovskii, I. R.; Vysochanskii, V. S.; Golovko, M. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 29p. (In Russian). Dep. NTIS (U. S. Sales Only).

9184 (ITF-72-78-P) THEORY OF INCOHERENT REFLECTION OF ELECTROMAGNETIC WAVES FROM PHOTOELASTIC MEDIA, WHICH ARISES FROM FLUCTUATION OF SURFACE WAVES. Grechko, L. G.; Kotsarenko, N. Ya.; Fedorchenko, A. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

9185 (ITF-72-84-P) RADIATIVE WIDTH OF IMPURITY CENTER LEVELS. Lubchenko, A. F.; Nguen Khac Nhap; Fishchuk, I. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

9186 (ITJ-19) INVESTIGATION OF MAGNETIC PROPERTIES OF ZnV_2O_4 SPINEL. Niziol, S. (Institute of Nuclear Techniques, Krakow (Poland)). May 1972. 13p. Dep. NTIS (U. S. Sales Only).

9187 (JINR-E4-6589) ELECTRONIC DENSITY OF STATES IN THE WEAIRE MODEL OF AN AMORPHOUS SOLID. John, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 6p. Dep. NTIS (U. S. Sales Only).

9188 (JINR-E4-6641) METAL-INSULATOR TRANSITION AND LIFSHIZ INSTABILITY IN THE HUBBARD MODEL. Weller, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 20p. Dep. NTIS (U. S. Sales Only).

9189 (JINR-E4-6643) EFFECT OF CRYSTAL-FIELD ANISOTROPY ON CURIE TEMPERATURE OF HEISENBERG FERROMAGNET. HTS EXPANSION METHOD. Brankov, J. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 19p. Dep. NTIS (U. S. Sales Only).

9190 (JINR-P13-6565) DIFFRACTION GRATING WITH AN INTERRUPTION AS A NOVEL OPTICAL ELEMENT. Soroko, L. M.; Suetin, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

9191 (K-AA-1033) TIME AND MATERIAL CONTRACTS. [Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.]. [nd]. 13p. (CONF-721040-1). Dep. NTIS.
From 16th annual AEC contractors purchasing agents conference; Cincinnati, OH (24 Oct 1972).

9192 (KFKI-72-52) MOESSBAUER EFFECT STUDIES ON FROZEN SOLUTIONS. Dezsi, I. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1972. 25p. (CONF-720834-2). Dep. NTIS (U. S. Sales Only).
From International conference on applications of the Moessbauer effect; Galilee, Israel (27 Aug 1972).

9193 (LA-5032) COMPUTER ANALYSIS OF DIFFERENTIAL LIGHT SCATTERING FROM COATED SPHERES. Brunsting, A. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 10p. Dep. NTIS.

9194 (LA-5039) WATER SUPPLY AT LOS ALAMOS DURING 1971. Purtymun, W. D.; Herceg, J. E. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 30p. Dep. NTIS.

9195 (LA-5063) ON THE USE OF AN ELECTRODELESS RING-DISCHARGE SOURCE TO SEPARATE THE SECOND AND THIRD SPECTRA OF CHLORINE. Radziemski, L. J. Jr. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 4p. Dep. NTIS.

9196 (LA-tr-72-25) ON THE BIRTH OF LIMIT CYCLES FROM A SEPARATRIX. Leontovich, E. Translated by Anna Vakar (Los Alamos Scientific Lab., N. Mex.), from Dokl. Akad. Nauk SSSR; 78: 641-4(1951). 7p. Dep. NTIS.

9197 (LBL-877) PERMEATION OF SILICATE LIQUIDS INTO SINTERED MAGNESIA COMPACTS. Wong, Boon (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 87p. Dep. NTIS.
Thesis.

9198 (LBL-1111) ELECTROCHEMICAL BEHAVIOR OF THE ALKALI METALS IN PROPYLENE CARBONATE. Jorne, Jacob (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 283p. Dep. NTIS.
Thesis.

9199 (LBL-1255) LARGE SEPARATIONS VIA CYCLING ZONE ADSORPTION. Rieke, R. D.; Pigford, R. L. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 288p. Dep. NTIS.
Thesis. Submitted by R. D. Rieke.

9200 (LIB/Trans-458) MECHANISATION AND AUTOMATION OF WELDING SEAM TESTING BY ULTRASONICS WITH SPECIAL REGARD TO THICK WALLED CONTAINERS. Meyer, H. J. Translated by U. Engelbert (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Proceedings of the 1st Colloquium, Welding in the Nuclear Technology, Frankfurt/Main, 12-13 November 1970. 20p. (CONF-701144-1). Dep. NTIS (U. S. Sales Only).

9201 (MLM-1995(TR)) COMPARISON OF THE INFRARED REFLECTION SPECTRA OF COMPRESSED MINERAL POWDER WITH THOSE OF THE CORRESPONDING MONOCRYSTALS. Vergnoux, Anne-Marie; Brunel, Rene. Translated for Mound Lab., Miamisburg, Ohio, from Compt. Rend., Ser. A, B; 265: 1097-9(1967). 6p. Dep. NTIS.

9202 (ORNL-NSF-EP-28) SAMPLE: A TWO STAGE LEAST-SQUARES PROGRAM WITH DATA TRANSFORMATION CAPABILITIES. Westley, G. W. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 41p. Dep. NTIS.

9203 (ORNL-TM-3912) ANNUAL CONSUMPTION OF ^{137}Cs AND ^{60}Co LABELED PINE SEEDS BY SMALL MAMMALS IN AN OAK-HICKORY FOREST. Mathies, J. B.; Dunaway, P. B.; Schneider, G.; Auerbach, S. I. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 232p. Dep. NTIS.
Thesis. Submitted to Michigan State Univ., East Lansing.

9204 (ORNL-tr-2573) CORROSION OF METALS BY TEMPERATURE GRADIENTS IN MOLTEN SALTS. MODEL CALCULATION OF THE DISTRIBUTION OF CURRENT BY MEANS OF ELECTRODE KINETICS. Hoff, H. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Electrochim. Acta; 16: 1357-68(1971). 18p. Dep. NTIS.

9205 (ORNL-tr-2614) REPRODUCIBILITY OF SPECTRAL LINE INTENSITIES IN LASER MICROSPECTRAL ANALYSIS. Moenke, Horst; Moenke-Blankenburg, Lieselotte; Mohr, Joachim; Quillfeldt, Winfried. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Mikrochim. Acta; No. 6, 1154-73(1970). 29p. Dep. NTIS.

9206 (ORNL-tr-2642) EQUATION OF STATE OF ARGON AT VERY HIGH PRESSURES AND ITS COMPRESSIBILITY IN A SHOCK WAVE. Bergeon, R.; Kieffer, J.; Vodar, B. Translated by R. G. Mansfield (Oak Ridge National Lab., TN), from J. Phys. (Paris); 16: No. 10, 813-14(1955). 4p. Dep. NTIS.

9207 (ORO-3628-6) MECHANISMS OF INNATE IMMUNITY. VI. BIOLOGICAL PROPERTIES OF POLYMORPHONUCLEAR LEUKOCYTE CYTOPLASMIC GRANULES AND THEIR COMPONENTS. Progress Report, December 1, 1971-December 1, 1972. Spitznagel, J. K. (North Carolina Univ., Chapel Hill. Dept. of Bacteriology and Immunology). 1 Dec 1972. Contract AT(40-1)-3628. 34p. Dep. NTIS.

9208 (ORO-3992-97) BLACK BODY HEAT CAPACITY AND ACTION AT A DISTANCE ELECTRODYNAMICS. Gleeson, A. M. (Texas Univ., Austin. Center for Particle Theory). Jun 1972. Contract AT(40-1)-3992. 17p. (CPT-151; CONF-720646-2). Dep. NTIS.
From 3rd Rochester conference of coherence and quantum optics; Rochester, NY. (21 Jun 1972).

9209 (OSU-CISRC-TR-72-10) LOSCHMIDT'S AND ZERMELO'S PARADOXES DO NOT EXIST. Rothstein, Jerome (Ohio State Univ., Columbus. Computer and Information Science Research Center). Oct 1972. 11p.

9210 (PNE-WW-19) CULTURAL AND ENVIRONMENTAL SURVEY STUDIES: 1971. Dolenc, M. R.; Power, D. V.; Hamlett, C. T.; Samaniego, H. (El Paso Natural Gas Co., Tex.). 25 Aug 1972. 102p. Dep. NTIS.

9211 (PRNC-157) ANNUAL REPORT, 1971. (Puerto Rico Nuclear Center, San Juan). 1971. Contract AT(40-1)-1833. 153p. Dep. NTIS.

9212 (RFP-Trans-105) OBSERVATION OF STRESS WAVE EMISSION FROM A MODEL PRESSURE VESSEL DURING LOW-CYCLE FATIGUE TESTING. Hatano, H.; Niwa, N.; Kurosawa, S.; Ando, Y. Translated for Dow Chemical Co., Rocky Flats Div., from Hihakai Kensa; 21: No. 4, 238-41(1972). 10p. Dep. NTIS.

9213 (RFP-Trans-106) EXPERIMENTAL STUDY ON DETECTION OF STRESS WAVE EMISSION. Hatano, H. Translated for Dow Chemical Co., Rocky Flats Div., from Hihakai Kensa; 20: No. 11, 597-604(1971). 19p. Dep. NTIS.

9214 (RFP-Trans-107) STRESS WAVE EMISSION FROM A MODEL PRESSURE VESSEL AND ITS SOURCE LOCATION. Hatano, Hajime; Sagehashi, I. A.; Yoshida, Yasunari; Niwa, Noboru. Translated for Dow Chemical Co., Rocky Flats Div., from Hihakai Kensa; 21: No. 4, 234-7(1972). 10p. Dep. NTIS.

9215 (RISO-M-1554) HYBRID COMPUTER FORTRAN IV INTERFACE SUBROUTINE FOR EAI 680-PDP8/I,FPP12. Hoejberg, K. S. (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov 1972. 12p. Dep. NTIS (U. S. Sales Only).

9216 (RISO-M-1555) AUTOMATIC STATIC TEST, POTENTIOMETER SETTING AND READOUT IN HYBRID COMPUTER EAI 680-PDP8/I,FPP12. Hoejberg, K. S. (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov 1972. 23p. Dep. NTIS (U. S. Sales Only).

9217 (SC-CR-68-3639) DEVELOPMENT OF NEW DIELECTRIC SYSTEMS TO PROVIDE A MINIMUM VOLUMETRIC EFFICIENCY OF TEN JOULES PER CUBIC INCH. Quarterly Progress Letter No. 1, February 8, 1968-May 8, 1968. (Sprague Electric Co., North Adams, Mass.). 22 May 1968. 11p. Dep. NTIS.
For Sandia Labs., Albuquerque, N. Mex.

9218 (SC-CR-68-3747) DEVELOPMENT OF NEW DIELECTRIC SYSTEMS TO PROVIDE A MINIMUM VOLUMETRIC EFFICIENCY OF TEN JOULES PER CUBIC INCH. Quarterly Progress Letter No. 2, May 8, 1968-August 8, 1968. (Sprague Electric Co., North Adams, Mass.). 9 Sep 1968. 12p. Dep. NTIS.
For Sandia Labs., Albuquerque, N. Mex.

9219 (SC-CR-68-3815) DEVELOPMENT OF NEW DIELECTRIC SYSTEMS TO PROVIDE A MINIMUM VOLUMETRIC EFFICIENCY OF TEN JOULES PER CUBIC INCH. Quarterly Progress Letter No. 3, August 8, 1968-November 8, 1968. (Sprague

Electric Co., North Adams, Mass.). 3 Dec 1968. 21p. Dep. NTIS.
For Sandia Labs., Albuquerque, N. Mex.

9220 (SC-CR-69-3104) DEVELOPMENT OF NEW DIELECTRIC SYSTEMS TO PROVIDE A MINIMUM VOLUMETRIC EFFICIENCY OF TEN JOULES PER CUBIC INCH. Final Report, November 8, 1968–February 9, 1969. (Sprague Electric Co., North Adams, Mass.). 4 Mar 1969. 35p. Dep. NTIS.
For Sandia Labs, Albuquerque, N. Mex.

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Thesis.

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